Oct 66

Three Steps to Sideband

Part 1-The CQ-90

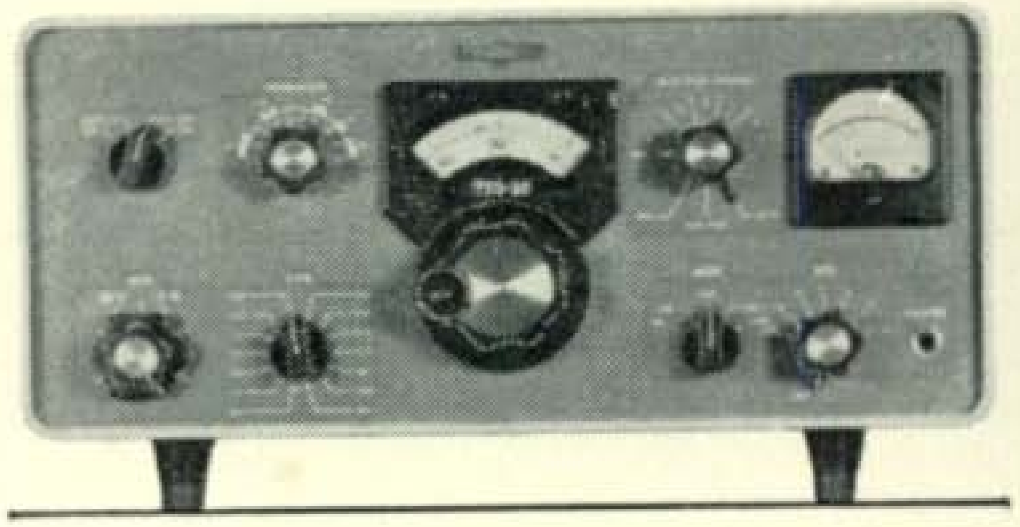
An All-Band 7360 Converter

Roll Your Own Low-Pass Filters

2 Kw Using 1 Kw Linears & Diplexers

Amateur Radio's All-Time Phone Champions. **page 32**

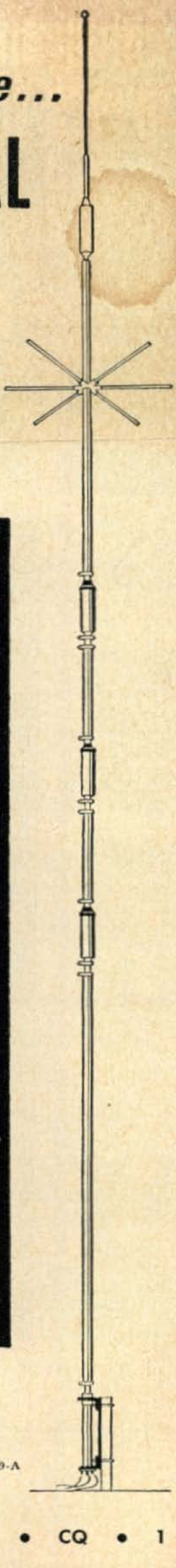
The Radio Amateur's Journal



73, Old Man! No matter what language it comes booming in on, you've made a good QSO. And you can work the best with Collins' S/Line. One star of this *complete* fixed station is the 75S-3B, featuring *sharpest selectivity* on SSB, CW and RTTY — optional filters that give you up to three degrees of selectivity in CW/SSB, and with a filter socket for AM–rejection tuning, AGC, and spinner tuning knob. Contact your authorized Collins distributor today. You'll be surprised to find how little it costs to own the finest.

COLLINS

For further information, check number 49 on page 112



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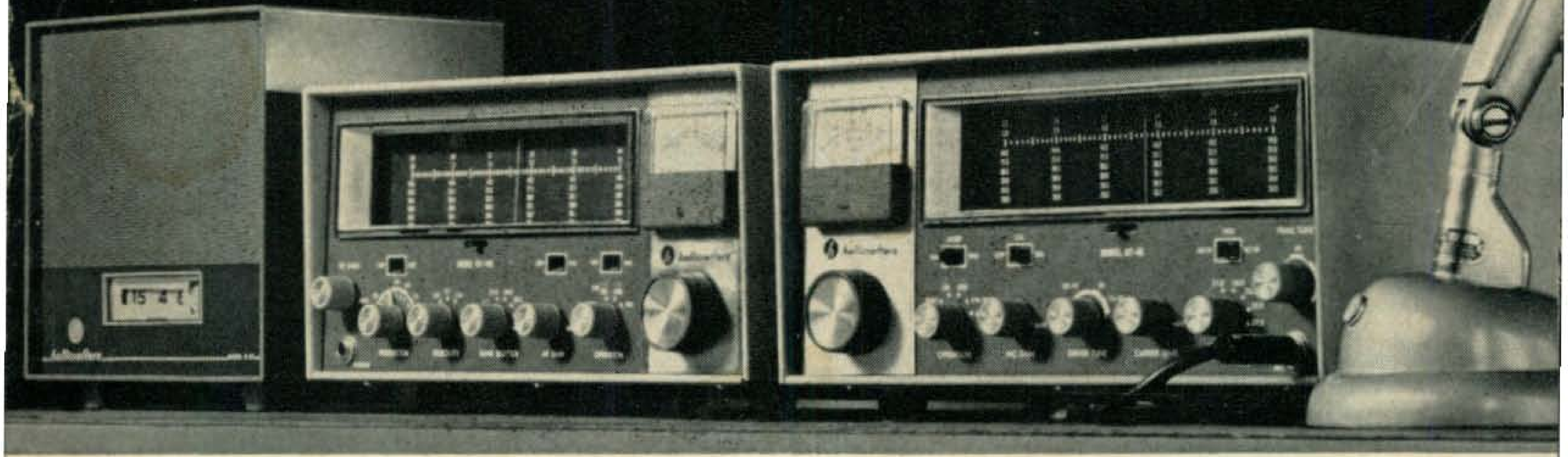
Hallicrafters advanced technology brings you a new breed of amateur equipment



SX-146 Receiver

This is an amateur band receiver of advanced design employing a single conversion signal path and pre-mixed oscillator chain to assure high order frequency stability and freedom from adjacent channel cross-modulation products. The SX-146 employs a high frequency quartz crystal filter and has provision for installation of two more crystal filters. The receiver may also be used from 2 to 30 mc, with the exception of a narrow gap at 9.0 mc, with the connection of auxiliary oscillators. The highly stable conversion oscillator chain may be used for transceiver operation of the matching HT-46 transmitter.

FREQUENCY BANDS: 3.5-4.0; 7.0-7.5; 14.0-14.5; 21.0-21.5; 28.0-28.5; 28.5-29.0; 29.0-29.5; 29.5-30.0 mc (28.0 to 28.5, 29.0 to 30.0 requires extra crystals at users option).

SENSITIVITY: Better than 1 µv for 20 db S/N.

TUBES AND FUNCTIONS: 6JD6 RF amplifier; 12AT7 Signal mixer and cathode follower; 6AU6A 9 mc IF amplifier; 12AT7 AM detector—AVC rectifier—product detector; 12AT7 USB—LSB crystal oscillators; 6GW8 Audio amplifier and audio output; 6BA6 Variable frequency oscillator; 6EA8 Crystal heterodyne oscillator and pre-mixer; Plus diode power supply rectifier, ANL diode and AVC gates diode; *6AU6A—100 kc crystal calibrator oscillator; *Harmonic generator diode.

PHYSICAL DATA: Size: 5⅞" x 13⅛" x 11". Shipping wt., 20 lbs.

FRONT PANEL CONTROLS: Frequency: Power off CW-upper-lower and AM; Audio gain; Band selector—3.5, 7.0, 14, 21.0, 28.0, 28.5, 29.0, 29.5; Selectivity—0.5, 2.1, 5.0 kc (0.5 and 5.0 kc filters optional extra); Pre-selector; RF gain; AVC on-off; Cal. on-off; ANL on-off; Phone set jack; S-meter.

REAR CHASSIS: S-meter zero adjust; Internal-External oscillator switch; Slave oscillator output; External oscillator input; Antenna socket; Speaker, ground and mute terminals; Grounding stud; AC power cord.

POWER REQ.: 105/125 volt—50/60 cycle AC—55 watts.

I-F SELECTIVITY: Uses a 6-pole crystal filter to obtain a nose-to-skirt ratio better than 1 to 1.8.

Amateur net, $269.95

Model HA-19 plug-in, 100-kc quartz calibrator available as accessory. **Amateur net, $19.95**

**Part of HA-19 calibrator.*

HT-46 5-band transmitter

All new from the ground up! Here's the "new breed" transmitter that matches your SX-146 . . . works independently or may be interconnected for transceiver operation.

FEATURES: 180 watts PEP input on SSB; 140 watts on CW; Frequency control independent or slaved to SX-146 receiver; Upper or lower sideband via 9 mc quartz filter; Built-in power supply; Press-to-talk or optional plug-in VOX; grid block for keying for CW.

FREQUENCY COVERAGE: 3.5-4.0, 7.0-7.5, 14.0-14.5, 21.0-21.5 mc and 28-30 mc in four 500-kc steps. Crystal supplied for 28.5-29.0 mc coverage. Other plug-in crystals at user's option.

TUBES: 6BA6 VFO; 6EA8 Heterodyne crystal oscillator and mixer; 12AT7 Carrier oscillator-third audio; 12AT7 Mic amplifier; 6EA8 9 mc I-F amplifier and AALC; 6AH6 Mixer; 12BY7 Driver; 6HF5 Power amplifier; 0A2 Reg.

FRONT PANEL CONTROLS: Frequency Tuning; Operation-Off, Standby, USB, LSB, CW-Tune, Standby LSB USB; Microphone gain; Driver tune; Carrier level; Band selector; Final tune; VFO selector—Transmitter-Receiver; Dial cal.; Calibrate Off-On; Meter MA-RFO.

REAR APRON FUNCTIONS: AC Cord; Ground lug; Fuse; Key jack; VOX accessory socket; Antenna jack; Receiver input (for transceiver); 11 pin control socket; bias adjust.

PHYSICAL DATA: Size: 5⅞" x 13⅛" x 11". Shipping wt., 26½ lbs.

HA-16 Vox Adapter, **$37.95** **Amateur net, $349.95**

R-51 Speaker.

4 x 6 inch oval speaker and attractive 24 hour clock.

amateur net $34.95

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For further information, check number 11, on page 112

CQ

OCTOBER 1966

VOL. 22, No. 10

The Radio Amateur's Journal

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ZERO BIAS

Since first suggesting some months ago, (July *CQ*, to be exact), that CBers might be people, too, I've received quite a broad selection of correspondence ranging from wildly laudatory tones to an occasional "drop dead" letter. It's to be expected, I suppose, but what I didn't really expect was such a great number of amateurs who also have sly suspicions that at least some CBers are humans—walking erect on their hind legs, having no more than two eyes symmetrically placed astride, a rather ordinary nose, and speaking some dialect of our already dialectical version of the English language. Ah, yes, maybe there's still hope for this troubled world of ours when a peppery old-time ham can look himself square in the eye and admit that he have been wrong to sneer at that CBer-kid around the corner who asked him how far he could talk.

Oh, the millennium hasn't come—not this year at least, but if a few second-rate editorials in a ham radio magazine can foster a little more mutual respect between two services, and even bring a few dozen more newcomers into the hobby, then think of what might come out of a major campaign. Yeah, there might still be a thing called ham radio ten years from now!

It's a little hard to figure, but since July, the number of requests for information about how to become an amateur has just about quadrupled here at *CQ*. The requests have come from CBers! How much encouragement did we give them? How did we entice them? Who spoon-fed them? Nobody did—all we did was say that we'd welcome them as hams—they took the intiative from there. Well, that blows one old argument all to heck—the argument that says that CBers are just too fat, dumb and happy to get in out of the rain, let alone work for a ham ticket.

What's that you say?—those old law-breaking CBers are going to create havoc on the ham bands if they ever do get their tickets? Here's news for you, old fella, we've already got some 15,000 amateurs on the air who either came through the CB route or who now hold CB licenses. Where's the havoc they're supposed to be creating? Funny, all I hear on 20 meters is a bunch of hams! Don't talk to me about "video rangers" either. I heard them on 2, 6, and 10 meters long before CB ever came about. And they're still there! I'm not excusing our own lids, I'm just trying to put blame where it belongs.

In this month's letters column, "Our Readers Say, "WA5IYX makes an interesting, if ill-conceived, point. He says 'OK, let's follow your reasoning and put the lawbreaker in a place where his operations would be legal. Let's put the counterfeiter to work at the Bureau of Engraving.' Interesting, except that Pat is putting all 800,000 CBers in the same category—he's classifying them all as Federal law violators who should be promptly locked up. But let's examine these "lawbreakers."

How did they become aware of CB radio's existence? Through personal contact with it, surely, but more important, through advertising on every level from newspaper ads to TV shows to *Playboy* magazine. And how has it been portrayed for these seven years? As a free, simple, fun-type method of talking to his buddies, for whatever purpose. We see young children being indoctrinated to the pleasures of CB with new "toy" walkie-talkies at $9.95 a pair. Is it any wonder that they graduate smoothly to bigger and better equipment, still with that same carefree attitude they were taught from the outset. No, it's easy to undersand why CB radio is the way it is, but its loose legal attitudes do not in any way mean that a CBer turned ham must be a liability. As long as amateurs continue to shut their doors to the CB operator who might like to try his hand at the "big leagues," amateur radio, I'm afraid we're going to be hamstrung by faltering growth rates which barely equal our attrition rates. To those who cry for more spectrum space through *fewer* amateurs, I say, put on your bi-focals OM, you obviously can't see ten years in front of you. Unfortunately, a growing number of amateurs are falling into the trap of believing that amateur radio ends at 28.7 mc. My friend, it just *begins* there. We've *got* room to grow—not below 29.7, but above. To sit in your rocker and lament that this is the best of all possible worlds, and we'd better stop growing or we'll run out of room, is to begin writing the epilog for a wonderful hobby—long before one is due.

73, Dick, K2MGA

OUR READERS SAY

Hams and CBers

Editor, *CQ:*

Regarding your ZERO BIAS of July and August, I have a few comments. While *some* CBers would probably make excellent ham material, *most* of the 11-meter inhabitants should not be allowed communications beyond the telephone.

You seem to suggest that the chronic CB violator is a poor victim of circumstances. He has a proclivity for hamming, but is not energetic enough to get a license. I suppose you believe that this violator of Federal law would become an angel on the hambands. The CBer with his little linear amplifier would make fine material for the "California kilowatt" group.

If we follow your reasoning (*i.e.*, getting the CBer to a place where his operations would be legal), we should place the maker of counterfeit money in the Bureau of Engraving where his talents would not go to waste. There are almost limitless examples just as absurd.

There are enough CBers on the hambands now, and unless CB is cleaned up first, I do not want any more extracts from its ranks. The person with a genuine desire for a ham license would not fall into the CB ditch. Help the legal CBer only (or those who have learned the FCC means business by having to hand out a few $100 in fines), not the chronic violator who may be finding it a little too dangerous to keep up his hamming on CB. This latter type has not been caught, and therefore he may very well continue to snub the FCC rules on his new found amateur bands.

It would be easier to recruit the would-be CBer to hamland. At least he won't have to be half remade.

Pat Dyer, WA5IYX/5
Austin, Texas

Editor, *CQ:*

Your editorial in the July *CQ* made me realize what is wrong with most hams today. It is not their contempt for users of the Citizen's Radio Service (CB) but it is their general apathetic attitude towards promoting the hobby.

I am not a "CBer" and right now I am struggling to obtain my Novice license. I don't seem to have done anything to offend the adult hams necessary to supervise a Novice test, so what's my trouble? My trouble, and most other people's is why there is a mass migration to the Citizen's Band. Adult hams think ham radio calls should have stopped with the first WA's.

Maybe I'm being too harsh, but if the difficulty I'm having with finding someone close to my home to supervise a Novice test is any indication, the number of hams will continue to decline. Perhaps (I hope) I have just been unlucky and the few hams I've approached are a minority, whatever the case something must be done. Some guys say "Oh the heck with that *#$?@¢ ham license, I'm going CB." And we all know what that means. Some other guys, who are really dedicated to ham radio will say "Nuts with this Novice thing, I'm going for my General." It's bad for a guy with no experience to go on the air, I wouldn't really feel "at home" the first time. When the Novice license was thought up it was a good idea, but what good is it if you can't get it (even when you know the code and theory!).

Ted Banks, WA???
Chicago, Illinois

"OUR READERS SAY" welcomes letters about nearly anything of interest to amateurs, whether about *CQ* itself, the state of the hobby, or whatever else you have on your mind. The most interesting letters will be selected for publication each month; just keep them legible, keep them short, and above all, keep them clean! Something bothering you. We're not mind readers, OM, so drop us a line.

Editor, *CQ:*

Suggest you figure out where the loyalty of *CQ* lies. The CB operator has made his contribution to the art. His utter disregard of (a) good manners (b) and obedience to the rules regarding the CB service are testimony enough regarding his ability. Something for nothing breeds this kind of attitude. No one should have to tell you this.

James R. Belt, Jr., WA0JIH
Parkville, Missouri

My loyalty is to God, country, and amateur radio. Where's yours?—K2MGA

Editor, *CQ:*

A pat on the back to you for your very sensible editorials on the CBer.

John C. West, W9NHF, KNJ0278
Chicago, Illinois

Of Sattelites and Thyngs

Editor, *CQ:*

Congratulations on a very unique and attractive green August cover, but "Sa*tt*ellite Weather Picture Via FAX" or Sa*t*ellite? Welcome to the clubb!

Big Ben, K9MFZ
Springfield, Ill.

Our proof-reader (me) is thoroughly embarrassed by his inability to spell, but only two other readers spotted the goof! Watsamatter with you guys! Don'cha' read?! *—K2MGA*

C.W. In Vietnam

Editor, *CQ:*

Our copies of *CQ* are a month or so late in most cases. However, late or not, I feel that most amateurs are not aware of the importance of that outmoded, slow, and to quote K8RSC, "laborious" method of communication called c.w. [LETTERS, June, p. 10].

C.w. is far from being dead. C.w. is being used extensively here in Vietnam. The Army Special Forces and the Air Force's Commandos as well as the Navy all use c.w. The Army Special Forces use c.w. almost exclusively in these dense jungles.

A.m., s.s.b. and f.m. will not carry through the underbrush for a very long distance—in some cases a kw s.s.b. won't go 10 miles and f.m. won't go a hundred yards. But the old standby gets through.

These people must have good communications and c.w. is the most consistent and the only reliable means of getting through.

I'm not an old timer nor am I a c.w. bug, but we had better hang on to c.w. and hope we don't wind up out in the boonies with a rig that won't operate c.w. with Charlie in the area.

I've been on the air over 12 years and I hope that no one ever takes the c.w. monkey off the radio amateur's back.

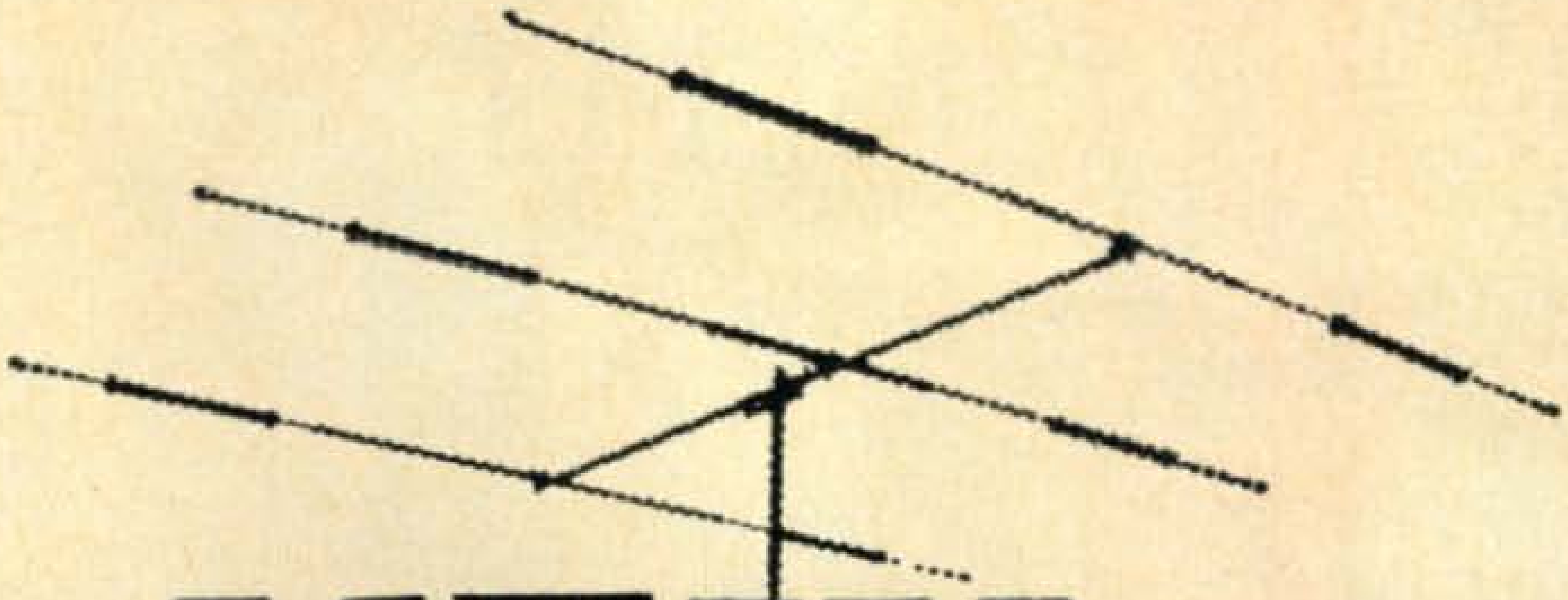
Ken Mulkuy, W0VPK
Control Center
Airborne Battlefield Command
Project Tiger Hound
APO 96337

P.S.: There are a lot of hams here in Vietnam that would like to get on the air—even if only c.w. There is *no* amateur operation here and even c.w. would be welcome.

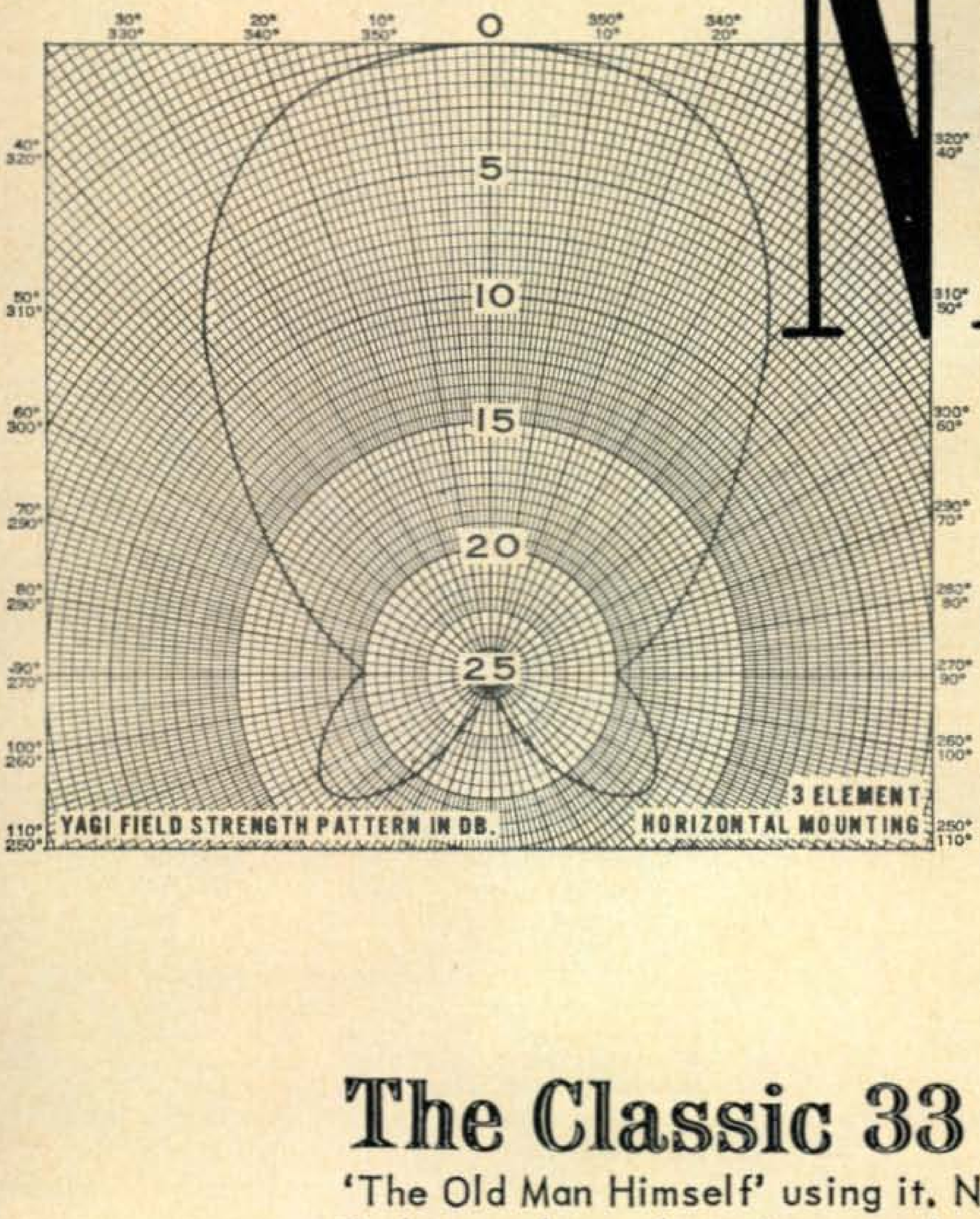
Editor, *CQ:*

I have just recently had a chance to buy the June issue of *CQ*. This is the first time since I have been here that I have been able to buy *CQ*. In "LETTERS TO THE EDITOR" a Mr. W. W. Warner, K8RSC, has said it would better the hams cause to drop code from the General test.

I agree with you 100% about keeping the code test! My father was a ham, W8CYN, before he passed away, and he was an expert at the key. I am studying now for my General so I might take the test on return to the United States. Whenever anyone asks me about ham



Mosley TRAP MASTER



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The Classic 33 You've been hearing about it – maybe you've worked Carl Mosley W0FQY– 'The Old Man Himself' using it. Now here it is . . . A Revolutionary New 3-element beam featuring an advanced Mosley-engineered matching system called 'Broad Band Capacitive Matching' with coax fed balanced element for more efficient beam performance and extra gain over comparative 3-element beams. A New Tri-Band beam rated for 1 KW AM/CW & 2 KW P.E.P. input to the final amplifier SSB on 10, 15, & 20 meters; with a full 8 db. gain on all three bands over reference dipole (10.1 db. compared to isotropic source); a maximum front-to-back . . . . The CLASSIC 33 . . . This new rugged beam in the Mosley Trap-Master tradition of quality beams brings you all the exclusive features of high priced beams – added gain, improved boom to element and mast clamping; wider element spacing. Priced well within your budget. What more could you possibly want in a 3-element Tri-Band beam? . . . .

. . . For Further Information Write Code 97 . . .

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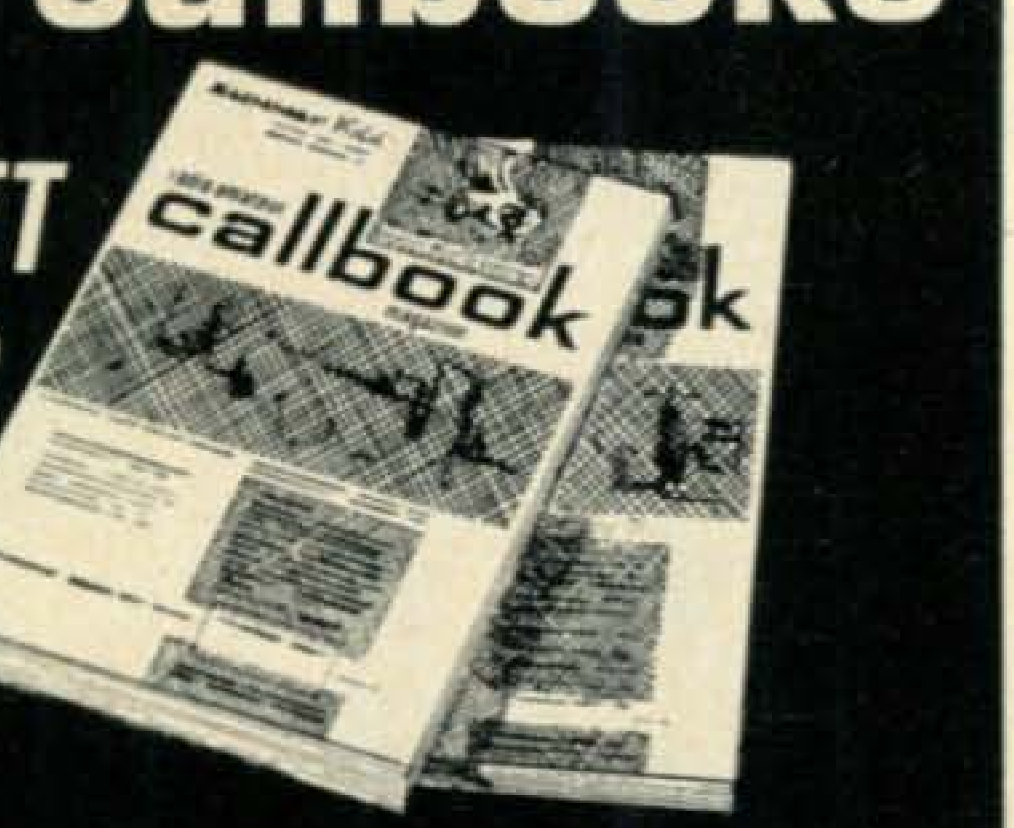

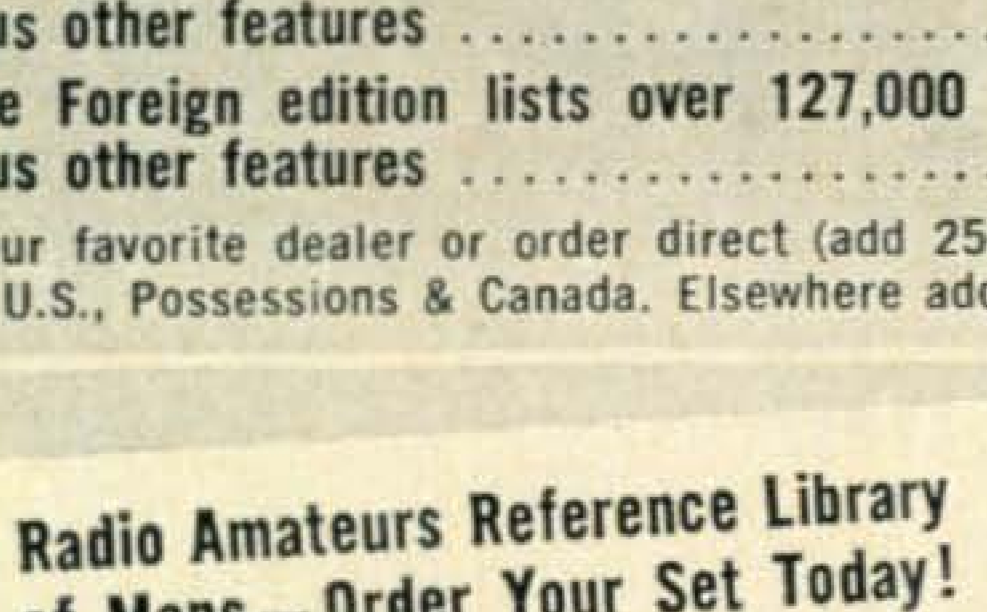

radio, one of the first questions is about code, and how fast a person can copy. So I say keep code in the test and three cheers for the "Brass Pounders!"

L/Cpl James J. Shoemaker
2103379 USMC
San Francisco, Calif. 96602

It's interesting to note that most of the letters we've received recently, supporting c.w. as the most universally valuable mode of communications, have come from men in the armed services. Not the crusty old-timers, mind you, but the young fellows. Many of them have had the "opportunity" to try its usefulness under the gravest of all conditions—the life-or-death battlefield situation. I don't know about you, fellows, but I respect *their* opinions.—*K2MGA*

The World's (Longest) Series

Editor, *CQ:*

After reading the July issue of *CQ* I heaved a sigh of relief to find that the marathon series "RTTY From A to Z" had finally concluded. I am not against RTTY as I have followed the series and found them well presented and written.

Surely if a series of articles is to be presented on any subject, RTTY, s.s.b., a.m., XYZ, etc. they should not drag out for 24 months. I have seen a series of articles extend over short periods, but never have I seen one extend for 24 months (RTTY from A to Z excepted).

I was staggered to find that this series is now, with additional information, to be published in book form. Why this was not done in the first place I will never know, and neither will a lot of other amateurs.

No, I won't be buying a copy of the book *RTTY From A to Z* as I have the last 24 issues of *CQ* and besides, the number of amateurs in VK using RTTY could probably be counted on the fingers of one hand. Surely this is not the only letter that you have received in protest against articles that run to 24 installments.

Lionel L. Sharp, VK4NS
Brisbane, Australia

Looking back on "RTTY From A to Z" we can understand reader Sharp's relief at the end of the series in *CQ*, but we don't have the slightest regret for having run it. Actually, the series began as a three-part treatise on RTTY, and as more research was conducted for background material, more and more interesting facets turned up which deserved exposure; hence, twenty-four articles. I can assure you though, that anyone with the faintest interest in RTTY would do well to reserve a copy of the forthcoming *CQ* Technical Series publication, *RTTY From A to Z*, which, with W2JTP's *New RTTY Handbook* will form the cornerstone of RTTY libraries for years to come.—*K2MGA*

VHF-UHF Passive Multipliers

Editor, *CQ:*

After reading the article, "VHF-UHF Passive Multipliers," by WA6SXC in the July issue, I would like to clarify a point.

Author Kolb infers that the term "varactor" applies only to step junction devices which operate as frequency multipliers primarily by non-linear variation in capacitance with changing reverse bias voltage. However, Motorola manufactures high power step recovery varactor diodes. They are capable of power outputs on the order of 180 watts at 100 mc, and 40 watts at 400 mc, when used in pairs; and 30 watts at 1 gc (1,000 mc), 10 watts at 2 gc, 5 watts at 3 gc, and over 2 watts at 7 gc using single devices.

The step recovery characteristics also result in excellent device linearity. This makes possible varactor multiplication of amplitude modulated signals with low distortion.

This letter is not meant to detract in any way from WA6SXC's excellent article; rather, it is meant to further inform your readers on state-of-the-art power varactor multipliers.

Roy Hejhall, K7QWR
Motorola Semiconductor Products, Inc.
Scottsdale, Arizona

Announcements

Perce Collison, W2KN

One of amateur radio's earliest and best-known operators, Perce Collison, W2KN, died in Bronx Veterans Hospital on August 20th after a long illness. Perce was originally licensed in 1912. A veteran of both world wars, Perce held the retired rank of Lt. Commander, USNR. A founding member of the IRE, predecessor organization to IEEE, Perce was an active operator, and a member of The Communications Club of New Rochelle.

New London, Conn.

The Tri-City Amateur Radio Club, Inc., of New London is holding its 19th Annual "Hamfest" at the Crocker House on State Street in New London, Connecticut on October 1, 1966. There is a maximum attendance of two hundred and fifty due to the limited facilities of the hotel. For more information write: Crocker House Hotel, State Street, New London, Connecticut, Attn: Tri-City Radio Club, Inc., 19th Annual Hamfest Committee, c/o Hotel Manager.

Syracuse, N.Y.

The Syracuse VHF Club Inc. will sponsor the 12th annual VHF Roundup to be held at the Country Manor, Route 49, Cleveland, New York, on October 8, 1966. This event has been attended by 600-700 people annually and is considered one of the outstanding v.h.f. amateur radio affairs in the eastern United States. For complete details contact: Philip E. Reilly, WA2IEL, Roundup Committee, Pine Grove Road, RD #3, Clay, New York 13041.

Bedford, Indiana

The Hoosier Hills Ham Club will hold its annual hamfest at Spring Mill State Park, Mitchell, Indiana, Sunday, October 9, 1966. S.s.b. dinner, nite before. For more information write P.O. Box 375, Bedford, Indiana.

Louisville, Kentucky

There will be a Louisville Ham "Kenvention" October 15, 1966 at the gigantic Kentucky Fair and Exposition Center in Lousville, Kentucky. For further information write: "Kenvention", P.O. Box 20094, Louisville, Kentucky 40220.

Tampa, Florida

The Hillsborough Amateur Radio Society (HARS) Annual Tampa Hamfest will be held on Sunday, October 16, 1966, 9:00 A.M.-4:00 P.M., Rowlette Park, Hillsborough River & 22nd Street. Free Lunch, large swap table area, free parking, lots of prizes.

Muskegon, Michigan

The 1966 Great Lakes Division Amateur Radio Convention will be held in Muskegon, Michigan, October 21 and 22. It will be sponsored by the Muskegon Area Amateur Radio Council and is scheduled to be one of the largest and finest ever staged in the Midwest.

This convention will be held in the L. C. Walker Sports Arena with 17,000 square feet of floor space. Complete information can be had by writing: Muskegon Area Amateur Radio Council, 2888 Scenic Drive, Box 691, Muskegon, Michigan 49443.

Oakland, California

The "Greater Bay Area Hamfest" will be held this year at the Edgewater Inn, in Oakland, Calif., on October 22 and 23, 1966. This will be the Fifth Annual holding of Northern California's largest hamfest. For detailed information write to: The Greater Bay Area, HAMFEST, P.O. Box 113, Hayward, California.

Turtle Creek, Pa.

The Tri State Sideband dinner in the Pittsburgh area will be held on Oct. 29 at Johnny Garneaus, Smorgasbord, Monroeville, Pas., 7:00 P.M. Check with C. J. Tirk, W3KTP, Turtle Creek, Pa., 15145, for more information.

Brownfield, Texas

The Brownfield Free Swapfest dates are October 29th-30th this year. Over 500 are always present, which makes this one of the largest in numbers attending. This event is sponsored by the Terry County Amateur Radio Club, Brownfield, Texas.

OSCAR NEWS

BY GEORGE JACOBS,* W3ASK

During late August, within 24-hours of each other, word was received from both Australia and Europe that completed and tested radio amateur communication satellites were on their way to the United States, to be launched in the Project Oscar series. The Australian satellite, called OSCAR-AUSTRALIS, was designed and built by members of the Melbourne University Radio Club (VK3ATM) working with members of the Melbourne University Astronomical Society. The European satellite, called OSCAR-EUROPA, was designed and built under the auspices of the Region 1 of the International Amateur Radio Union (IARU).

OSCAR-AUSTRALIS

The Australian-built radio amateur satellite contains an h.f. beacon transmitter, a v.h.f. telemetry transmitter and a command receiver and decoder. The satellite does not contain a translator, and will not be able to be used as a communications relay.

The h.f. beacon radiates a c.w. signal on 29.450 mc, with 250 milliwatts output. Every 70 seconds the identification letters "VK" will be sent 5 times. This transmitter will not run continuously owing to the heavy battery drain, and will be commanded ON and OFF from ground station control centers.

Besides providing an h.f. beacon signal for radio amateurs (this will be the first radio amateur satellite to do this), the OSCAR-AUSTRALIS satellite will contain several experiments of scientific value. One of these will be an effort to align an axis of the satellite along the earth's magnetic lines of force by the use of two magnets which will be aboard. If this is successful, it will reduce the tumbling effect, and consequent fading of signals. Information from within the satellite will be radiated back to earth by means of an eight-channel telemetry system operating on 144.050 mc. Sensors within the satellite will measure temperature at two locations, the horizon at two locations, battery voltage, current consumption, attitude of the magnets, and keyer operation. Each channel will

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transmit for ten seconds, including the "VK" keyer, which will be synchronized with the h.f. keyer transmissions. The v.h.f. beacon transmitter, however, will operate continuously.

A two meter command receiver and decoder will also operate continuously aboard the satellite. This will enable selected stations to turn the h.f. beacon transmitter ON and OFF depending on battery level and current consumption readings relayed back by telemetry. The h.f. beacon, although not operating continuously, is expected to provide propagation data which may be useful in designing a 10 meter translator planned for a future Oscar satellite. It will also enable a very large number of radio amateurs who do not have v.h.f. receiving equipment to participate in Oscar experiments.

OSCAR-AUSTRALIS has been completed and successfully tested in balloon flights. It is understood that the package is on its way to Oscar Headquarters at Foothill College, Los Altos, California.

OSCAR-EUROPA

Karl Meinzer, DJ4ZC, reports that the OSCAR-EUROPA radio amateur satellite is completed and tested, and on its way to Oscar Headquarters. Karl, along with G3HRH, G2AIW and DL1LS acted as technical coordinators for this Region 1 IARU project. The satellite was assembled by Karl. OSCAR-EUROPA is an active communication satellite, with a two meter transponder similar to Oscar 3. The transponder will receive signals between 144.06-144.14 mc, and retransmit them between 145-94-145.86 mc, with inverted sidebands. The transponder's power output is one watt p.e.p., and its life expectancy is eight weeks.

Also aboard the European-built radio amateur satellite will be a telemetry-beacon transmitter which will operate continuously on 145.95 mc. The telemetry signal consists of two "HIs" followed by an unmodulated carrier. The carrier duration and the total cycle represents battery voltage level and internal temperature, respectively. The beacon transmitter will have a power of 25 milliwatts.

The satellite's antenna system is circulary polarized to reduce signal flutter and Faraday rotation fading. This will also permit linearly polarized antennas to be used at ground stations with good results.

OSCAR-5

Oscar Headquarters is still planning to launch OSCAR-5 this fall, but at this time they still cannot say which satellite will be selected for this honor. The final choice may, as it has been in all previous launches, depend upon the launch vehicle that Oscar will be riding piggy-back, and size and weight limitations. Regardless of which satellite becomes OSCAR-5, a healthy supply of radio amateur satellites is arriving at Headquarters to insure continued growth of this space communications project. ■

Fig. 1—End result of a three step construction project, the CQ-150 Mark II is a 5 tube s.s.b./c.w. transmitter that features a self-contained power supply, stable v.f.o., push-to-talk relay, bandswitch for 80 or 20 meters, 150 watts p.e.p. input on upper or lower sideband, 150 watts c.w. input.

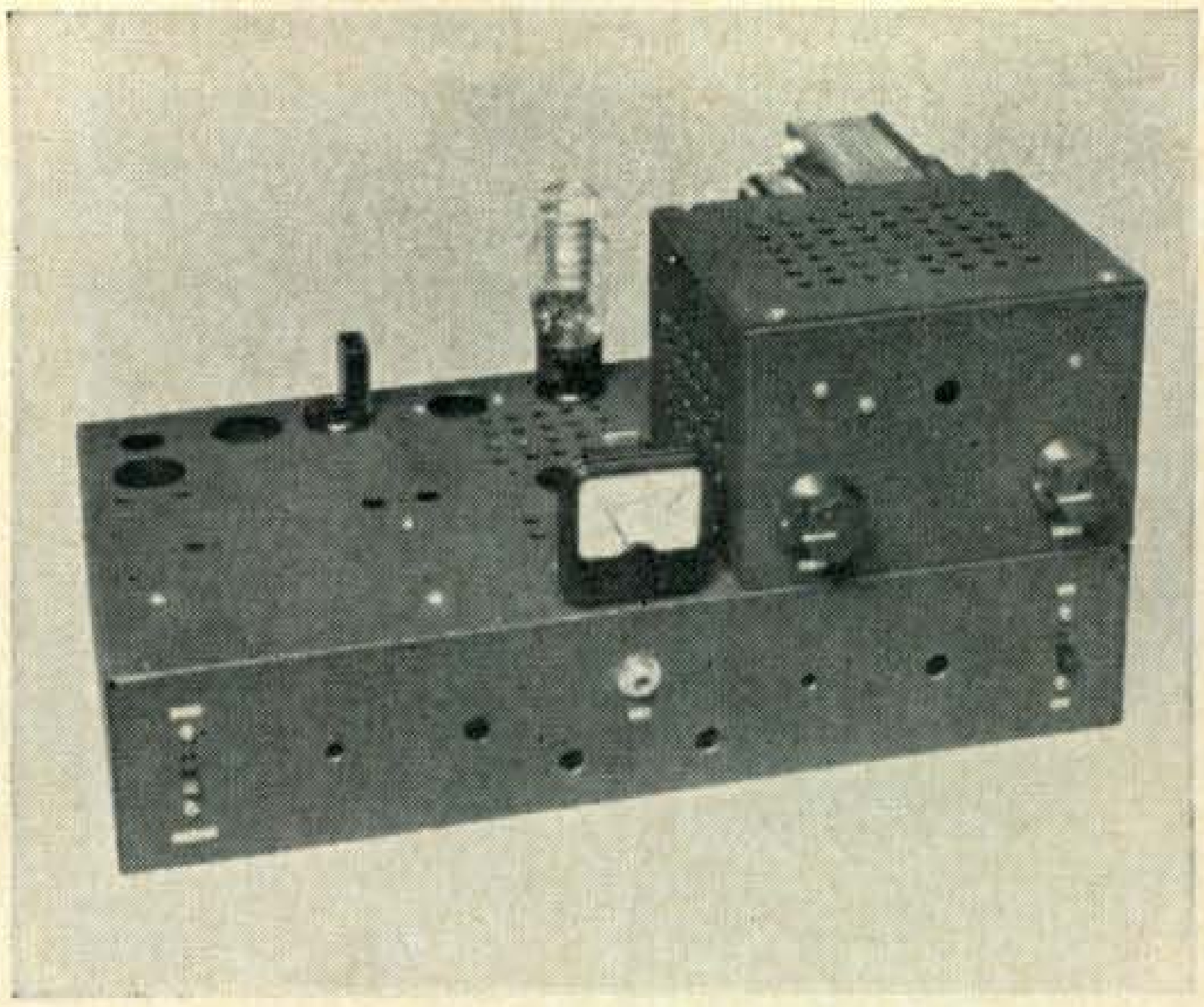

Fig. 2—First step in three part series, the CQ-90 is a one band c.w. transmitter with a maximum input rating of 90 watts. It may be wired for either 80 or 40 meter operation.

THREE STEPS TO SIDEBAND

BY HARTLAND B. SMITH,* W8VVD

Part 1: The CQ-90

A three part construction project begins this month with the details necessary to build a c.w. transmitter suitable for the Novice or the beginning General. Part II of this series will describe how to increase the c.w. power to 150 watts, add a v.f.o. and include bandswitching and 20 meter operation. Part III will describe the addition of the circuits and components necessary to put the rig on sideband.

THE newly hatched Novice and the low budget General share a common aspiration. Each dreams of the day when a single sideband transmitter will occupy a prominent position in his shack. However, either because he presently lacks low frequency phone privileges or because he is plagued with a shortage of funds, many a ham considers it impractical to plunk down a sizable amount of cash all at one time for a factory built s.s.b./c.w. rig.

The transmitter illustrated in fig. 1 is the end product of a three stage construction project which proves that the route to sideband need not be overly expensive. You can start by building the CQ-90, the one band crystal controlled rig shown in fig. 2. It may be wired to operate either on 80 *or* 40 meter c.w. and boasts an input rating of 90 watts.

Later on, when your bank account has recovered from the mild initial shock, you can change the CQ-90 into the CQ-150, a v.f.o. controlled bandswitching 80 and 20 meter c.w. unit rated at 150 watts input. Finally, with the addition of a crystal filter and a few more components, you'll become the proud possessor of the CQ-150 Mark II, a full fledged s.s.b.-c.w. transmitter. Total cost of the entire project, using all new parts, is approximately $120, a figure which is well below the price tags usually found on commercial sideband equipment.

This three-step approach to s.s.b. is particularly attractive to members of the flat purse gang since it doesn't require a fellow to lay out a great deal of cash before starting to build. Dividing the total cost into three fairly equal parts definitely eases exchequer strain. The Novice, too, will like this arrangement, because it allows him to get by without investing in a v.f.o. or modulator until his cherished General ticket finds its way into his mailbox. Another important advantage of three-step construction is that it minimizes wiring and adjustment difficulties. Upon completion of each unit, it may be thoroughly tested and even used on the air for several months before the builder proceeds with the next stage.

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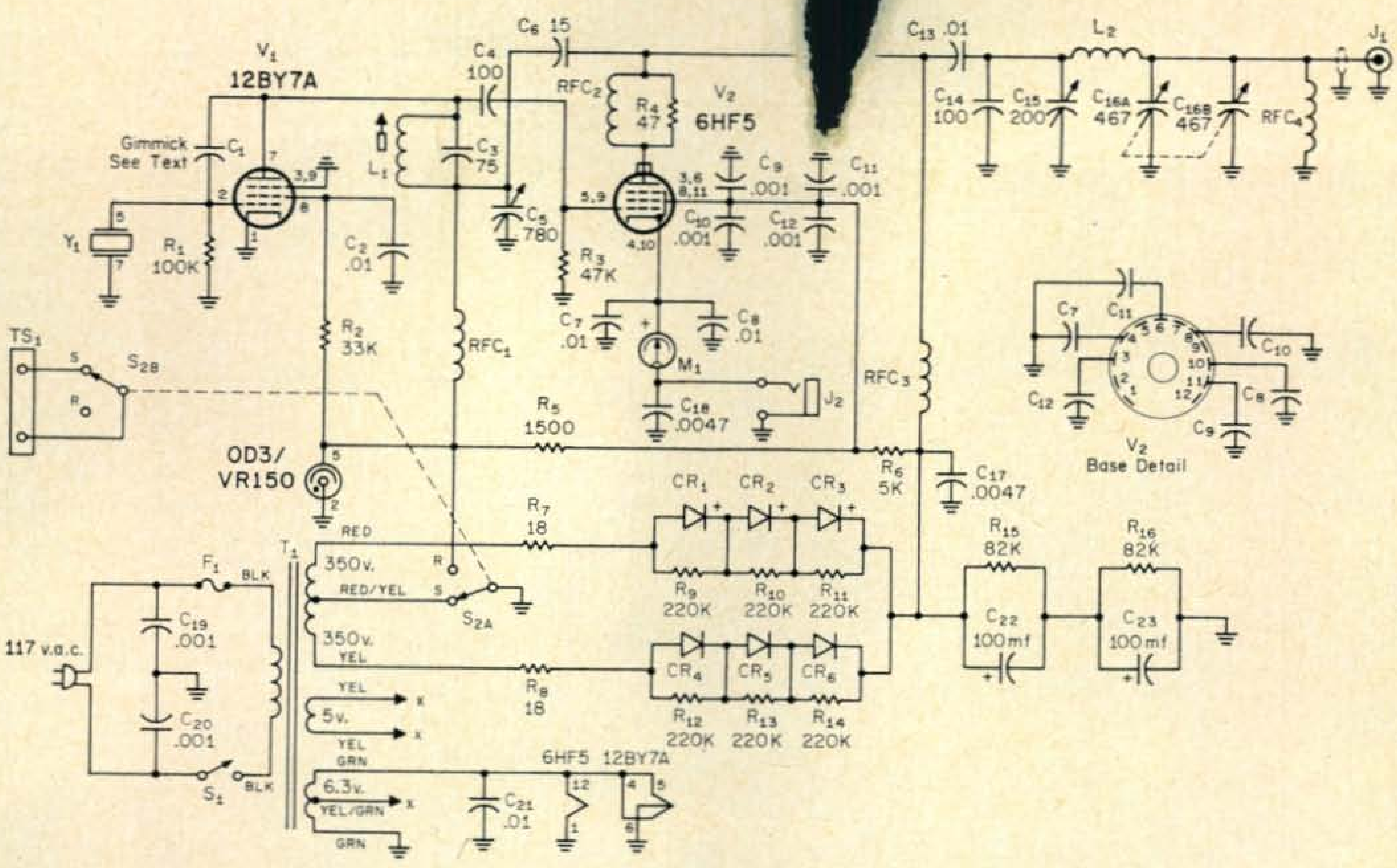


Fig. 3—Circuit of the CQ-90, the first construction stage of the sideband rig.

Parts List

C_1—Gimmick (see text).
C_2, C_7, C_8, C_{21}—.01 mf, 1000 volt disc ceramic capacitor.
C_3—75 mmf, NPO disc capacitor, Sprague 10TCC-Q75 or equiv.
C_4—100 mmf tubular ceramic capacitor.
C_5—170-780 mmf mica trimmer, Allied Radio 13U520 or equiv.
C_6—15 mmf, NPO disc ceramic capacitor, Sprague 10TCC-Q15 or equiv.
C_9, C_{10}, C_{11}, C_{12}, C_{19}, C_{20}—.001 mf, 1000 volt disc capacitor.
C_{13}—.01 mf, 1600 volt disc ceramic capacitor, Centralab DD16-103 or equiv.
C_{14}—100 mmf ceramic transmitting capacitor, Centralab 850S-100N or equiv.
C_{15}—200 mmf variable capacitor, Hammarlund MC-200M or equiv.
C_{16}—2 gang 15.5 to 467.8 mmf variable capacitor, Allied Radio 13U528 or equiv.
C_{17}, C_{18}—.0047 mf, 1000 volt disc ceramic capacitor.
C_{22}, C_{23}—100 mf, 450 volt electrolytic capacitor.
CR_1, CR_2, CR_3, CR_4, CR_5, CR_6—500 ma, 400 p.i.v. silicon diodes.
J_1—SO-239 Amphenol coaxial connector or equiv.
J_2—Open circuit phone jack.
L_1—46 turns, #28 enameled wire on a J. W. Miller 22A000RBI ½" diam. slug tuned form.
L_2—80 meters: 23 turns #18 wire, 1¼" diameter, spaced diameter of wire or Barker-Williamson 3019 Miniductor or equiv. 40 meters: 11 turns, #18 wire, 1¼" diameter, spaced diameter of wire or Barker-Williamson 3019 Miniductor or equiv.
M_1—500 ma d.c. meter, Emico RF-2C or equiv.
R_1—100,000 ohm, ½ watt resistor.
R_2—33,000 ohm, ½ watt resistor.
R_3—47,000 ohm, ½ watt resistor.
R_4—47 ohm, 2 watt composition resistor.
R_5—1500 ohm, 5 watt wirewound resistor.
R_6—5000 ohm, 20 watt wirewound resistor.
R_7, R_8—18 ohm, 1 watt resistor.
R_9, R_{10}, R_{11}, R_{12}, R_{13}, R_{14}—220,000 ohm, ½ watt resistor.
R_{15}, R_{16}—82,000 ohm, 1 watt resistor.
RFC_1, RFC_4—2.5 mh, 125 ma. r.f. choke.
RFC_2, RFC_3—See text.
S_1—SPST slide switch.
S_2—DPDT slide switch.
T_1—Power transformer. 700 volts center tapped at 120 ma., 5 volts at 3 amps, 6.3 volts at 4.7 amps. Knight-Allied Radio 61U430 or equiv.

Misc.

TS_1—2 screw terminal strip.
V_1—12BY7A tube.
V_2—6HF5 tube.
V_3—0D3/VR-150 voltage regulator tube.
Y_1—Quartz crystal ground for operating frequency.
F_1—3AG 3 ampere fuse.
Fuse holder for above.
1—3 × 15 × 8½" black wrinkle chassis, Bud CB-665 or equiv.
1—6 × 5 × 4" black wrinkle utility cabinet, Bud CU-729 or equiv.
2—Octal sockets, Amphenol 78S8 or equiv.
1—9 prong miniature socket with shield base, Amphenol 59-406 or equiv.
1—Shield for above socket, Amphenol 59-409 or equiv.
1—12 pin Compactron socket, Eby 9371 or equiv.
2—1 terminal tie points.
2—2 terminal tie points.
3—4 terminal tie points.
1—A.C. cord and plug.
1—8" length of RG-59/U coaxial cable.
1—3½" length of ⅝" polystyrene rod or tubing.
2—knobs.
Misc.—grommets, solder lugs, wire, solder, screws, nuts, #28 enamel wire, polystyrene cement, etc.

About The Circuit

The wiring diagram for the CQ-90 is shown in fig. 3. A 12BY7A, V_1, serves as a crystal controlled oscillator. A 6HF5 Compactron beam pentode, V_2, is the power amplifier. Both stages operate straight through. Thus, 80 meter crystals are required for 80 meter operation and 40 meter

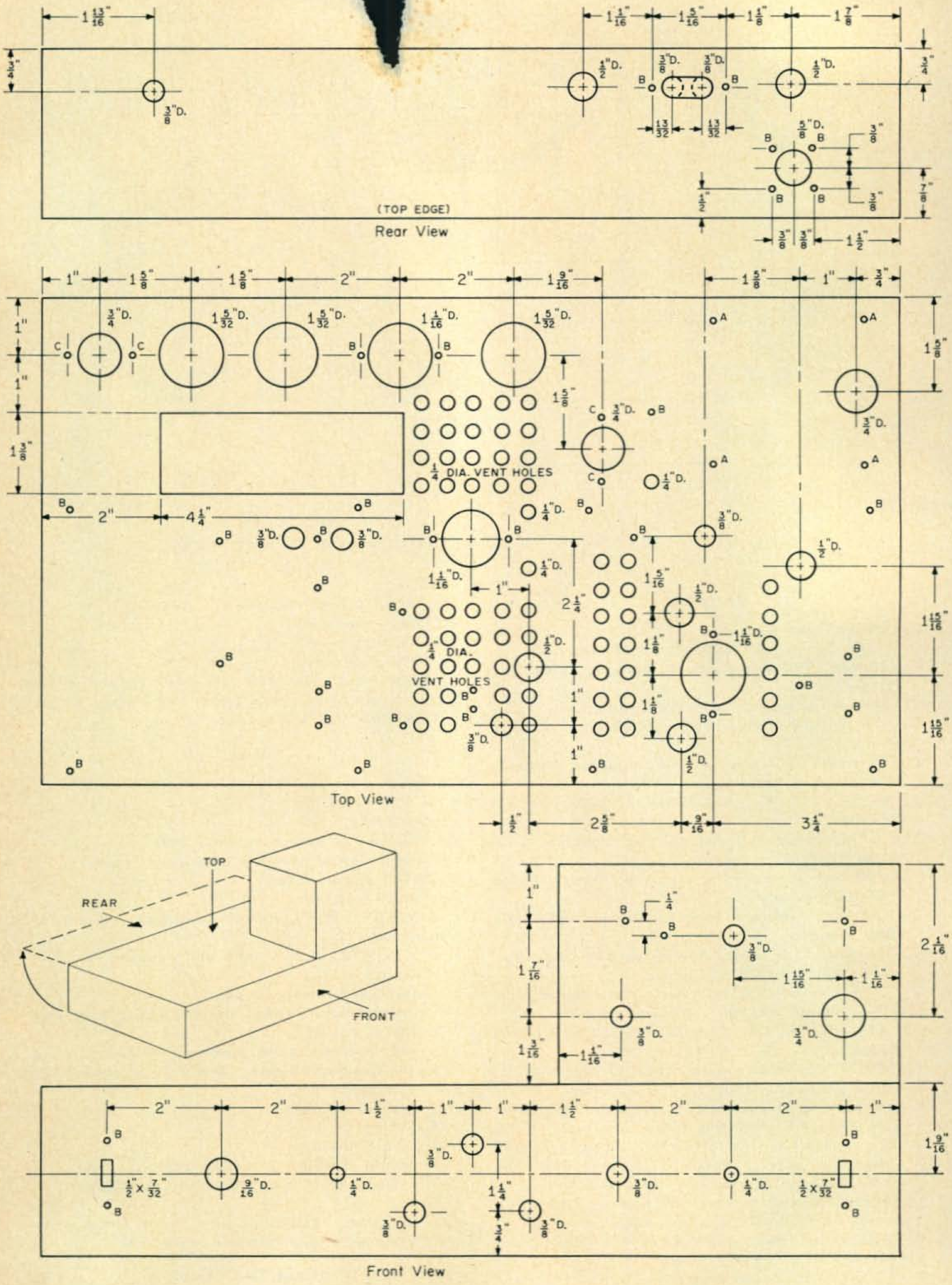


Fig. 4—Dimensional layout of the major chassis cutouts required for the three step sideband project. Holes marked A are made with a #18 drill, B a #28 drill and C, a #33 drill. The oblong hole on the rear flange is made by drilling two 3/8" holes and filing away the midsection. All ventilation holes are ¼" diameter. This drawing is shown approximately ⅓ of actual size. Full size reproductions of the drawing are available by writing the editorial dept. and enclosing one dollar.

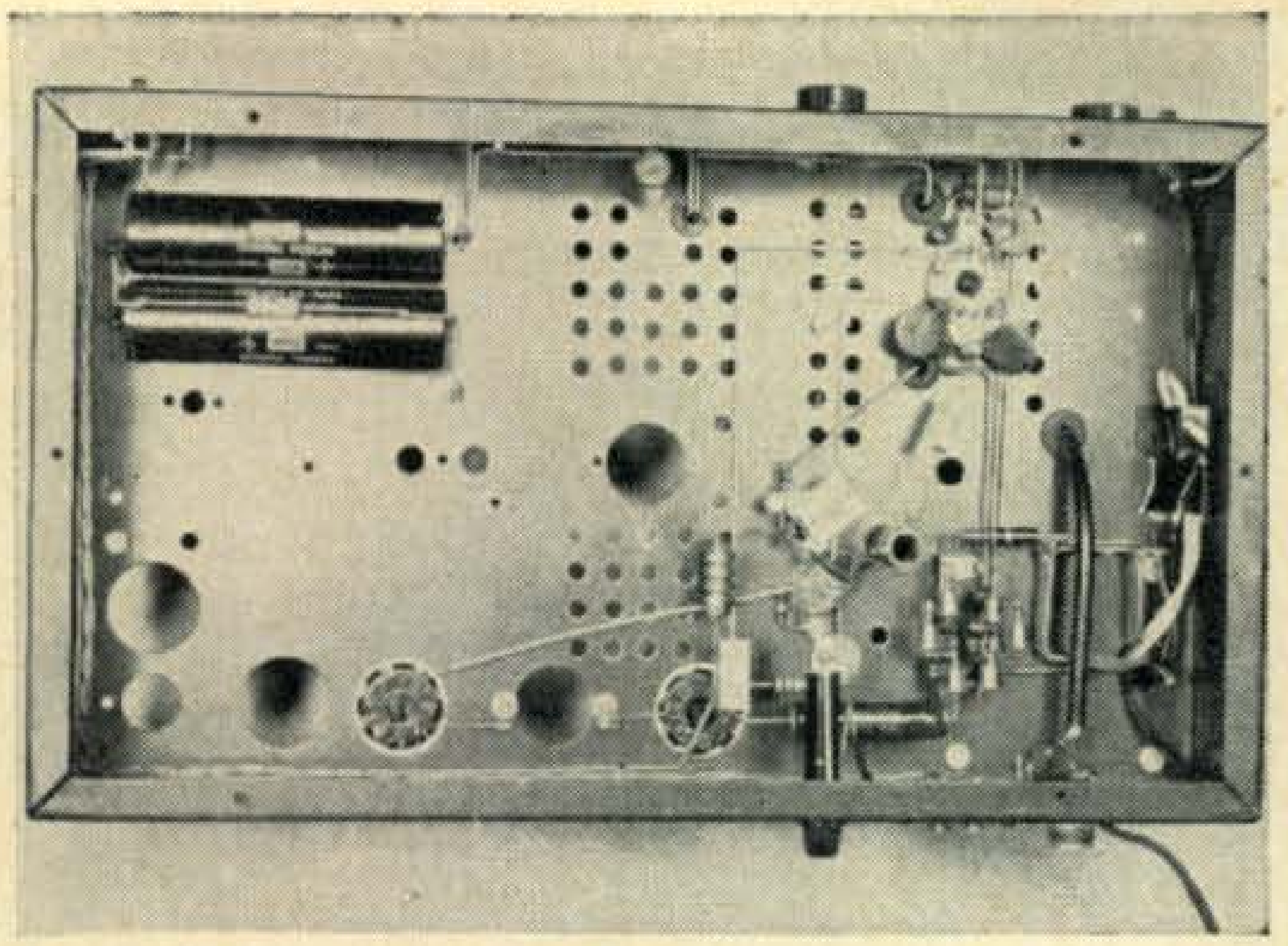


Fig. 5—Below chassis wiring is simplified by this uncrowded layout.

crystals for 40 meter operation. Components C_{14}, C_{15}, L_2 and C_{16} form a pi-network which matches the amplifier to a coaxial antenna feedline.

A 500 ma meter, M_1, indicates 6HF5 cathode current to facilitate tuning and loading. In order to prevent the generation of a chirpy signal, only the amplifier is keyed.

A bridge neutralizing circuit consisting of C_5 and C_6 serves two important functions. It prevents self-oscillation in the amplifier and keeps oscillator energy from reaching the antenna where it might cause an objectionable back-wave when the key is open.

Power for the transmitter is supplied by T_1 and a full wave rectifier circuit with six silicon diode rectifiers. Resistors R_7 and R_8 prevent current surges from damaging the diodes. Equalizing resistors, R_9 through R_{14}, prevent the buildup of excessive inverse voltage across any one diode. Capacitors C_{22} and C_{23} smooth the rectified direct current coming from the power supply. A voltage divider consisting of R_5, R_6 and V_3 supplies a fairly constant 185 volts to the screen of V_2 and, due to the regulating action of V_3, an exceptionally stable 150 volts to V_1.

Switch S_1 controls the a.c. power. Switch S_{2A} grounds the center tap of the power transformer in the SEND position. When flipped to the RECIEVE position it grounds the B supply line to V_1, instantly killing the oscillator which, due to the residual charge in C_{22} and C_{23}, would otherwise run for several seconds and QRM the station you're working. Switch S_{2B} is wired directly to terminal strip TS_1 so that it may be used to control an externally powered antenna change-over and receiver silencing relay.

The schematic shows the CQ-90 wired for 80 meter operation. If you prefer to work 40, remove C_3 and reduce the number of turns in L_2 as noted in the parts list.

Without RFC_4, which is included as a safety measure, a lethal 500 volts might appear on the antenna if C_{13} were to break down. To prevent this dangerous situation from occurring, the r.f. choke provides a d.c. path to ground which will overload the power supply and blow the fuse if C_{13} ever becomes defective.

Chassis Preparation

Since drilling and punching are rather difficult to manage after a few parts have been mounted, it will pay you to make the major chassis cutouts shown in fig. 4 right at the start, even though many of the holes won't be required until the second and third construction steps. As development of the original transmitter progressed, some of the holes visible in the photos proved to be unnecessary, while a few more had to be drilled later on. Figure 4 incorporates these minor revisions.

Although harder to work with than aluminum, steel is recommended for the chassis because of its strength. Black wrinkle finish is preferable to zinc plating or gray paint, not only because of its lower cost, but also because it does an excellent job of radiating heat.

A 6 × 5 × 4″ utility cabinet, minus its bottom cover, houses the 6HF5 and associated tuning components. Adequate ventilation must be supplied for the large amount of heat generated by the amplifier. Drill 24 ¼″ holes in each end and 48 in the top of the utility cabinet. Put 40 additional holes in the center of the main chassis between M_1 and V_3, and 20 more around the 6HF5 socket.

An 8⅜″ × 14⅞″ bottom plate with at least 50 ventilation holes may be fashioned from fairly stiff sheet steel or aluminum. Fasten it to the chassis with 6 self tapping screws. Add rubber feet, of course, to prevent desk scratching.

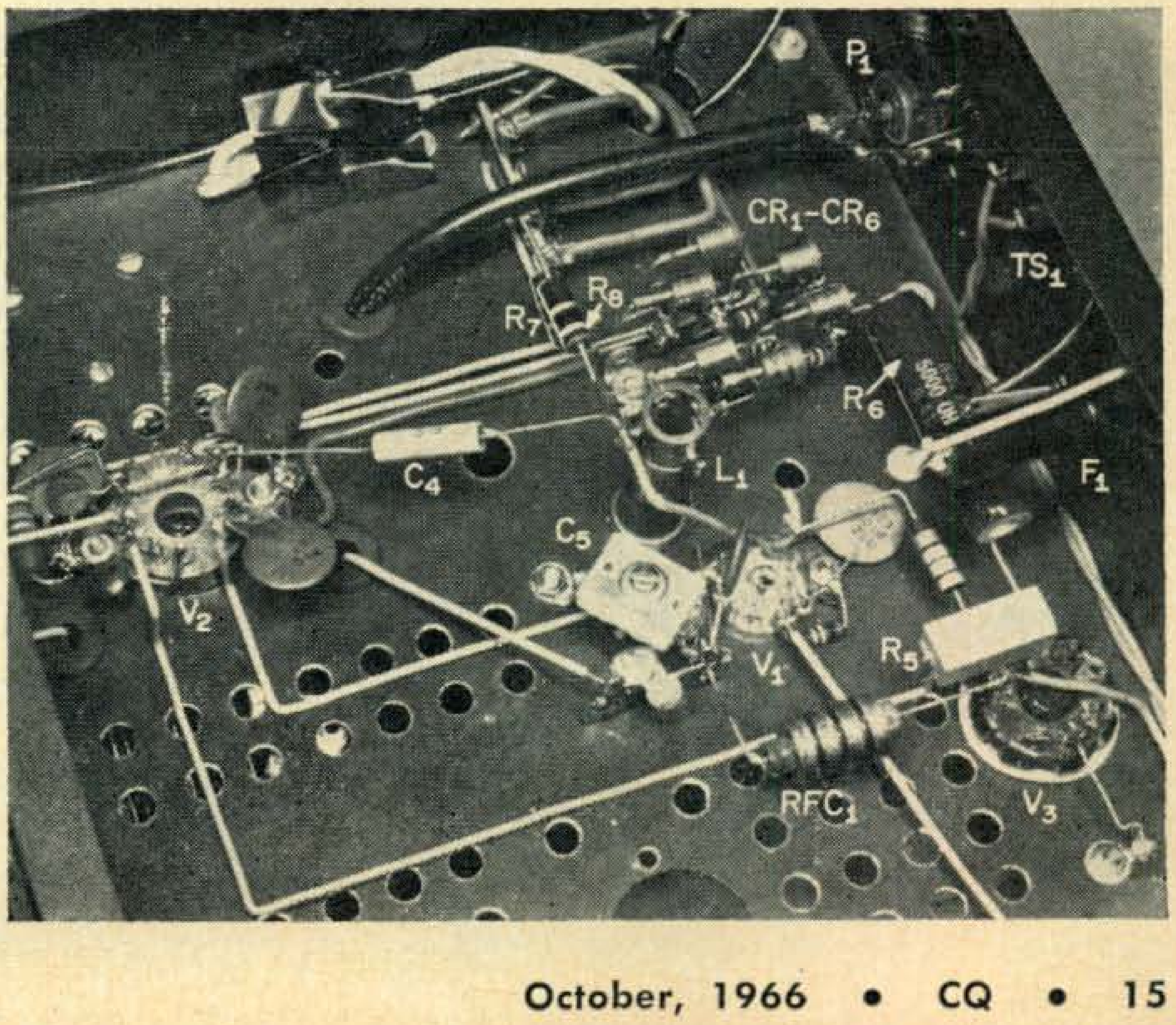


Fig. 6—Closeup view of the wiring associated with the tube sockets.

Wiring

Trim all capacitor leads until they are just long enough to reach their respective terminals. Capacitor C_1, known as a gimmick, provides the plate to grid feedback needed at V_1 to assure reliable crystal oscillation. Solder a 1¾″ piece of insulated hookup wire to pin 2 of V_1 and another 1¾″ piece to pin 7. The gimmick is then formed by twisting the two insulated wires together, being careful to prevent the exposed ends from shorting against each other.

You will note that the screen connections for V_2 are brought out to 4 different pins. A 0.001 mf capacitor must be connected between each one of these pins and ground. However, the screen voltage coming from the junction of R_5 and R_6 need only be attached to pin 3. Connect R_3 to pin 5 and C_4 to pin 9. Join pins 5 and 9 with a short piece of bare wire. Two cathode bypasses are required on the 6HF5, one at pin 4 and the other at pin 10. The positive wire from M_1 should be connected to pin 4.

Mount neutralizing capacitor C_6 on a two terminal tie strip (near C_5) as shown in fig. 6. The lead running from C_6 to the C_{13} end of RFC_3 should drop straight down from the choke, pass through a grommeted chassis hole and then go directly to C_6. Ground the terminal of C_5 which is riveted to the variable plate directly beneath the adjusting screw and washer. Solder the fixed terminal of C_5 to C_6.

Wind RFC_3 on a 3½″ length of ⅝″ o.d. polystyrene tubing. A short wooden plug cemented in one end of the choke will provide material for a mounting screw to bite into. The choke coil, itself, contains 180 turns of #28 enamel wire closewound in a single layer. Solder lugs at each end of the form furnish a convenient means for anchoring the wire and also serve as terminals for those components that connect directly to the choke. After winding the coil, give it two coats of polystyrene cement.

Construct RFC_2 by winding six turns of #14 enamel wire on R_4, a 47 ohm, 2 w. *composition* resistor. Space the turns the diameter of the wire.

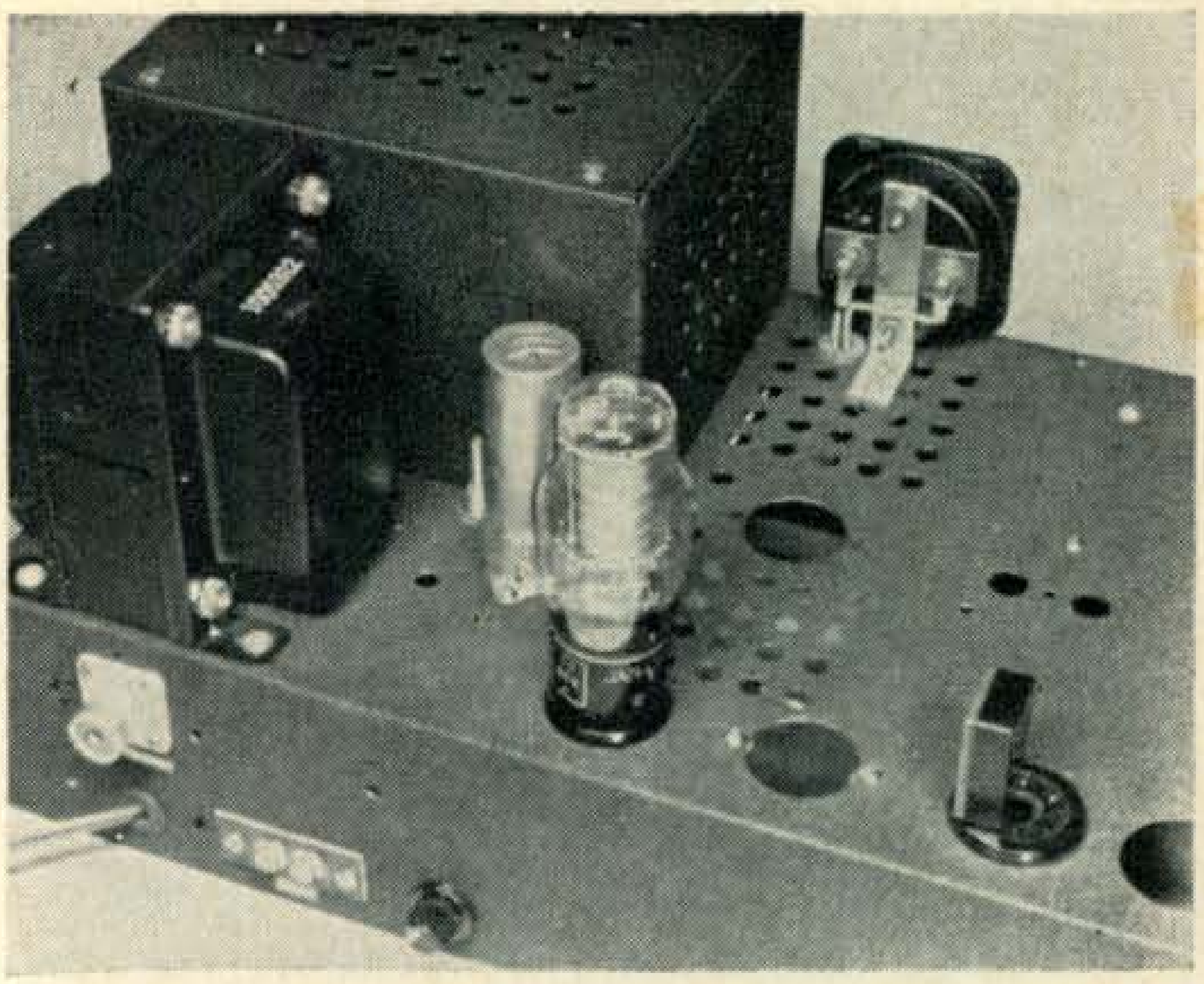


Fig. 7—Rear view of the chassis. The power transformer is on the left followed by V_1 under the tube shield and V_3, the voltage regulator tube. The crystal is on the right. The components on the rear of the chassis are, from left to right, J_1, TS_1 and F_1.

Before tightening its mounting nut, position C_{15} so that its rotor clears both V_2 and the side of the box as the capacitor is tuned. Capacitor C_{16} is supplied with two mica trimmers. Remove and discard the trimmer adjusting screws, the mica insulation and the two small trimmer plates.

Near the top, at the rear of C_{16}'s frame, you will note two holes. Bolt a one terminal insulated tie point at the hole nearest V_2 and fasten a ground lug at the other hole. The center conductor of a piece of RG-59/U coaxial cable approximately 8″ long is run between the one terminal tie point and the center contact of J_1. Ground one end of the cable's shield braid to the mounting foot of the tie point and the other end to a solder lug held by a J_1 mounting nut. RFC_4 goes between the tie point and the ground lug on C_{16}'s frame. Connect both stator sections of C_{16} together and then run a wire from the rear stator section to the tie point. Inductor L_2 is supported only by its leads. One end of the coil goes to the tie point and the other is attached to a stator lug on C_{15}. With the exception of the rather long lead running between C_{14} and C_{15}, keep the amplifier wiring as short and direct as possible.

Wires carrying a.c. or d.c. from the power supply may be of any convenient length. For the sake of neatness, run as many of them as possible around the edge of the chassis.

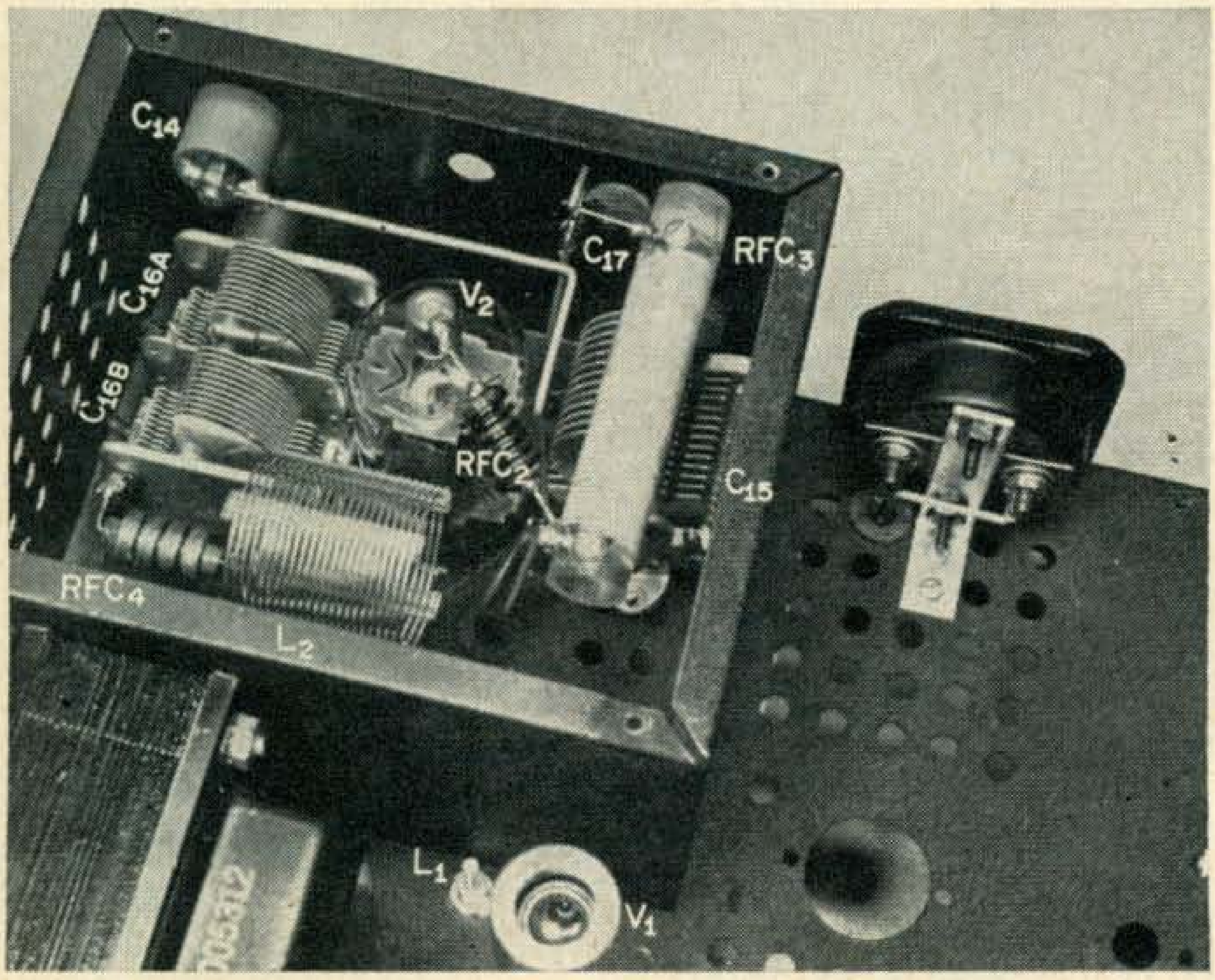


Fig. 8—Interior view of the final amplifier compartment.

Rectifier diodes CR_1 through

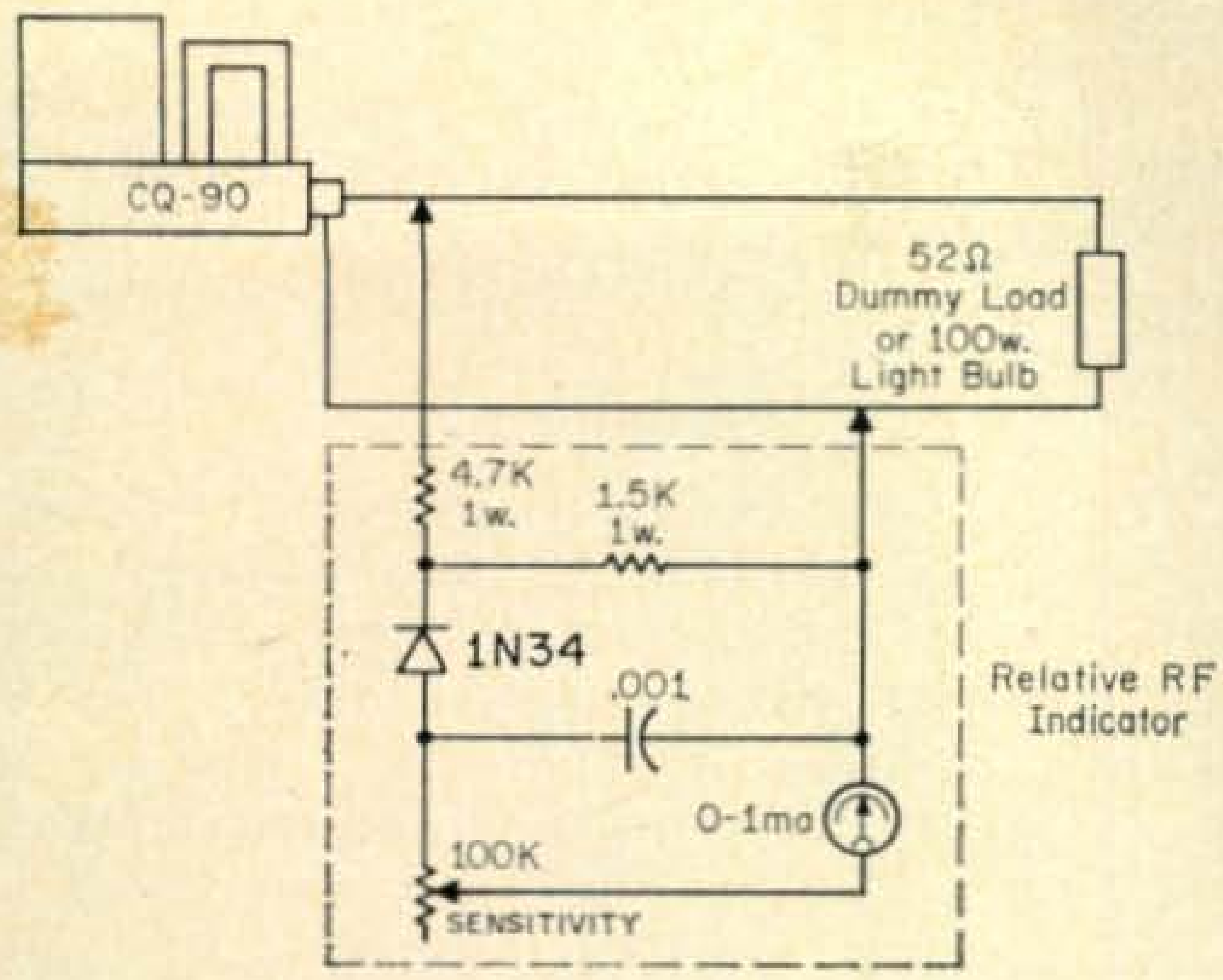


Fig. 9—Connections to the CQ-90 for tuning and neutralization.

CR_6, together with their paralleled resistors, are supported on two 4 terminal insulated tie strips. Protect the diodes from heat damage while soldering by clamping a pair of long nosed pliers to the lead between the point where the iron is applied and the body of the rectifier. Be very careful to observe the diode, electrolytic capacitor and meter polarities!

Since it won't be needed, cut off the yellow-green transformer lead and insulate the end with tape. The yellow transformer wires aren't used in Step 1. Tape their ends and tuck them in an out of the way corner.

Preliminary Adjustment

Twist the screw in C_5 clockwise until it is fairly tight. Set C_{15} and C_{16} at maximum capacity. Back the slug of L_1 all the way out. Plug in an appropriate transmitting crystal. Connect a dummy load and an r.f. voltage indicator between the center contact and ground of J_1 as shown in fig. 9. A light bulb (100 watts) may be used instead but it is not as desirable as the dummy load. Light bulbs will radiate a signal and they do not provide a perfect impedance match as their impedance varies with the light intensity. Plug in the a.c. line and turn on S_1. Do NOT plug in the key at this time.

Throw S_2 to SEND. Tune your receiver to the signal from the crystal oscillator. Slowly advance the slug in L_1 until oscillation stops. Now, back the slug out ½ turn to restore oscillation.

Plug in the key. Watch the meter while you hold the key down for not more than a half second. If the needle pins, the oscillator is quitting. Back the slug of L_1 out a quarter turn at a time until, when you close the key, the meter reads no more than 300 mils. Reduce the capacity of C_{15} until V_2's cathode current drops to a minimum. Decrease the capacity of C_{16} to the point where the r.f. indicator shows the greatest reading or the 100 watt bulb glows brightest. By jockeying C_{15} and C_{16} back and forth a bit, you should be able to get the maximum reading or make the bulb light almost to normal brilliance.

Practice tuning and loading until you are thoroughly familiar with the process and understand how output, as indicated by the output meter or bulb brilliance is affected by settings of C_{15}, C_{16} and L_1. Note, too, that overloading the amplifier will increase the cathode current, but will reduce the output power actually generated by the transmitter.

Later, when you hook up the antenna, the correct tuning procedure will be to dip the final current with C_{15}, increase the loading on the amplifier with C_{16}, redip the final, increase the loading some more until the current at the dip point is either 220 ma, if you're a Novice limited to 75 watts, or 280 ma if you're a General who may run the transmitter at its top rating of a little more than 90 watts.

Neutralization

The best way to neutralize the transmitter is with a sensitive r.f. indicator or field strength meter. After tuning the rig for maximum output, as indicated by the r.f. meter or light bulb, remove the key from J_2. With S_2 in the SEND position and the r.f. meter hooked across the terminals of the load or light bulb, adjust C_5 until the r.f. indicator reads minimum. During the process, monitor the oscillator signal in your receiver. If it stops, restore oscillation by tweaking the slug in L_1. If the r.f. indicator meter pins, when first connected, detune C_{15} just enough to bring the needle down off its peg or adjust the sensitivity control of the r.f. indicator.

An alternate neutralizing method is to set L_1 at the point where V_1 is almost ready to drop out of oscillation with the key up. When you close the key and tune C_{15} through its range, you'll note that the oscillator quits at certain settings of the final capacitor. Optimum neutralization will occur when C_5 is adjusted to minimize C_{15}'s effect on the oscillator.

Once V_2 has been neutralized, C_5 need not be

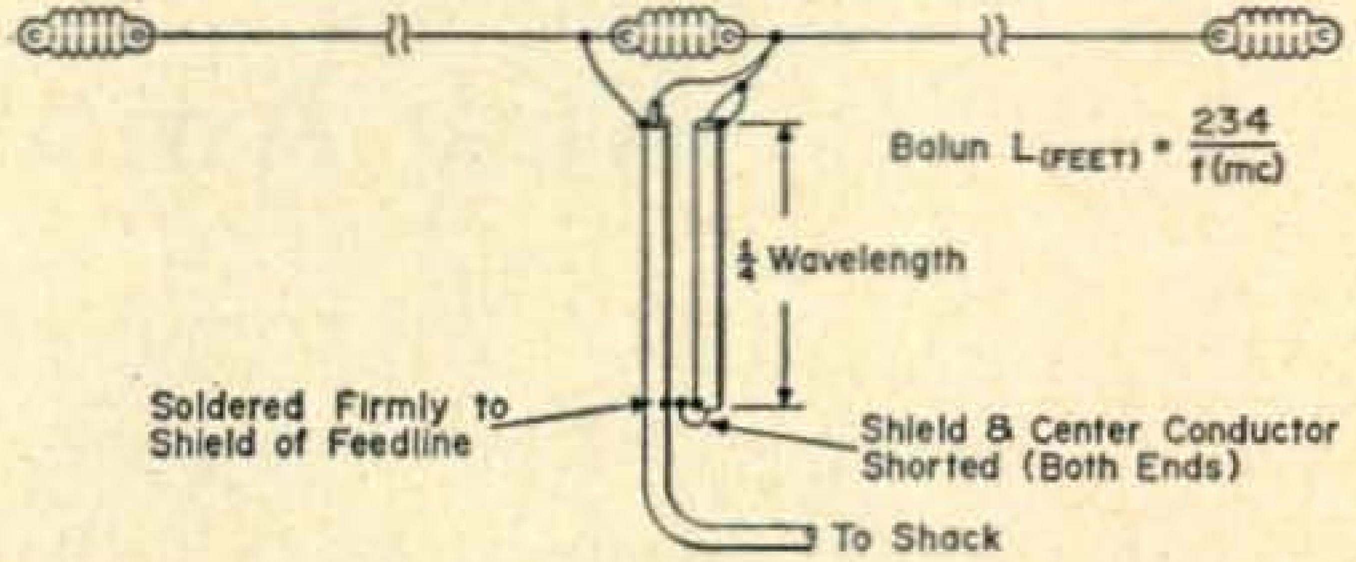


Fig. 10—Recommended antenna for the CQ-90 is a dipole fed by RG-59/U coaxial cable with a balun at the antenna feed point. Typical antenna measurements for the center frequencies of the Novice bands are shown below. The formula for calculating the length of the balun is shown above and details for constructing the balun are also shown.

Band	Antenna	Balun
80M	125' 7½"	62' 9¾"
40M	65' 2½"	32' 7¼"

touched unless you decide to try a different band. Since neutralization has to be made with the power on and the bottom plate removed, watch out for high voltage! Don't allow any portion of your anatomy to contact an under-chassis component.

Antenna

The simplest and best antenna for the CQ-90 is a single band dipole fed at the center with RG-59/U coaxial cable, as shown in fig. 10. Mount it as high in the air as possible and run it in a straight line if you can. Note the use of a balun at the feed point for a proper match from unbalanced coax to the balanced dipole.

Do not attempt to use a so-called "long wire" or random length antenna plugged directly into J_1. Results will be disappointing and harmonic radiation excessive.

On The Air

After attaching the coaxial feedline to J_1, turn on the rig. Plug in the highest frequency crystal you plan to use on the band you are set up for. Tune and load the transmitter as you did with the light bulb. Send a series of dots while listening on your receiver. Screw the slug of L_1 into the coil as far as you can without causing the signal to chirp. From now on the adjustment of L_1 may be ignored when changing crystals unless you shift down more than 100 kc. Capacitors C_{15} and C_{16}, however, may require a slight touchup whenever you QSY.

The pi-network will satisfactorily match resistive loads in the neighborhood of 75 ohms. Some antennas, due to standing waves on the feedline, may present a markedly different impedance to the transmitter. When this happens, C_{15} and C_{16} won't respond as they did with the dummy load at J_1. If, no matter how you adjust these capacitors, amplifier current fails to dip low enough to meet the Novice requirement or, on the other hand, refuses to rise sufficiently, even with the plates of C_{16} wide open, change the length of the feeder. Adding 20 feet or so of coaxial cable should correct the difficulty.

Precautions

The CQ-90 uses potentially lethal voltages. Except when neutralizing the amplifier, never work on the transmitter until you have disconnected the a.c. power plug and have flipped S_2 into the RECEIVE position. Whenever you are on the air make certain that both the bottom plate and 6HF5 compartment cover are bolted in place. Don't let you're fingers stray from the bakelite knob to the terminals of the key.

The 6HF5 will overheat and may be permanently damaged if you hold the key down for more than 30 seconds at a time while tuning up. Allow the final to cool at least a minute between each tuning attempt. If the oscillator stops for any reason, there will be no grid bias on the 6HF5 and its plate current will soar, pinning the needle of M_1. Should this ever happen, open the key *immediately* and leave it open until oscillation is restored.

Performance

The CQ-90 has furnished the author witn many fine QSO's. It performs as well as commercially built rigs of equivalent power and has evoked numerous unsolicited compliments regarding its signal quality. Stations in all parts of the country have been easily worked on both 80 and 40 meters. Readers who duplicate the unit will not only find themselves with an excellent c.w. transmitter, but will also be well on the way toward owning the 150 watt c.w. and s.s.b. units to be described in forthcoming issues.

[*To be continued*]

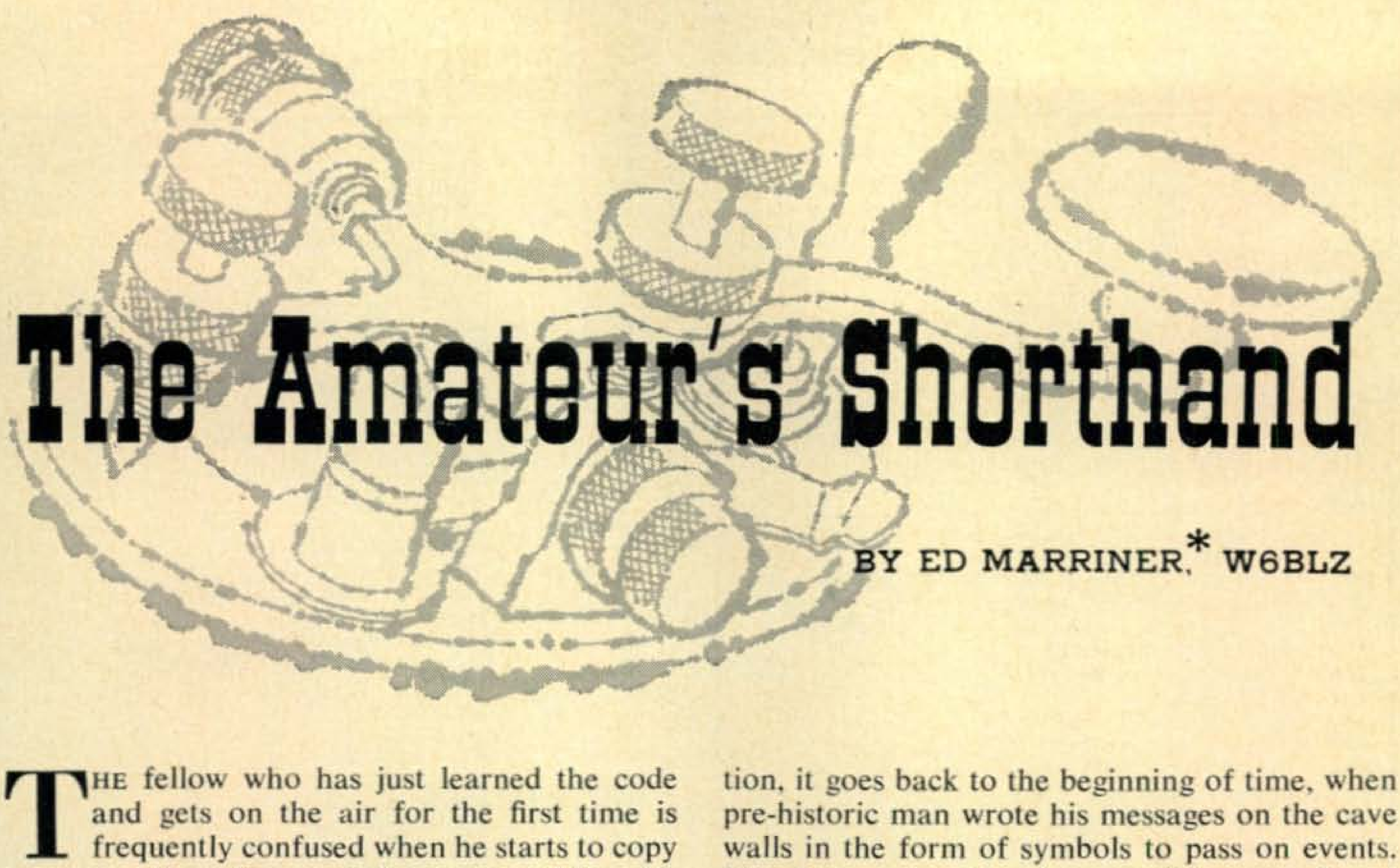
New Amateur Product

Lafayette Model HA-500 Receiver

LAFAYETTE Radio Electronics Corporation, 111 Jericho Turnpike, Syosset, L.I., N.Y. 11791 announces the new Model HA-500 Receiver, stock no. 99-2574WX, Price $149.95.

This ham band only receiver tunes 80 through 6 meters in six tuning ranges. Its features are: 10 tube superheterodyne circuitry utilizing dual frequency conversion on all bands; tuned r.f. and 1st mixer stages combine with two mechanical filters to provide good sensitivity with good skirt selectivity; product detector; "always on" oscillator filament increasing stability; built-in 100 kc crystal calibrator; S-meter; a.v.c. Size: 15" x 7½" x 10".

For more information either write directly or circle 75 on page 112.



The Amateur's Shorthand

BY ED MARRINER,* W6BLZ

THE fellow who has just learned the code and gets on the air for the first time is frequently confused when he starts to copy messages; they do not make sense to him. Although he has copied them correctly, they still look like "jibberish," but it is really a form of radio shorthand called the *Phillips Code*. It was designed by Walter P. Phillips, in 1879 as a telegraphic shorthand, primarily to help in the rapid transmission of press matter over the telegraph wires. It was copied with a pencil and translated for the typesetter by an editor. When the typewriter came into general use, the telegrapher copied the radio shorthand as plain language. This was quite an art and was not uncommon to find the operator copying a sentence behind, while lighting his pipe. This abbreviated code increased the manual copying speed to 50 words per minute or more.

Today, Phillips Code is a language used by many persons in connection with wire and radio telegraphy and in teletype communications. The abbreviations have changed little down through the years, except in cases of special usage in weather reporting, teletype messages or in amateur radio signals.

Besides the Phillips Code, there are other symbols frequently used by operators to represent entire sentences. Among these are, Q signals, which in amateur work are three letter words beginning with the letter Q, and followed by a question mark if it is to mean a question. Commercial and military circuits use a special form of signal called the Z signal which has a more broad meaning for that particular service, but is similar in construction. Other signals may creep in to confuse the operator such as punctuation marks, and signals to indicate spaces, breaks, questions and the beginning or ending of messages.

The art of writing fast is not a recent invention, it goes back to the beginning of time, when pre-historic man wrote his messages on the cave walls in the form of symbols to pass on events. The first systematic picture writing was found among the Sumerians of Southern Mesopotamia about 3000 B.C., and later on in Egypt. Writing was further developed by the Phoenicians into a system of 22 signs called the alphabet. The first sign, Aleph, as it was called, came from the sketch of a bull's head, and was used as the first letter in the alphabet.

As language developed, faster means of writing were needed to carry on business and stenography or shorthand writing was developed and became popular during the days of the Roman Empire. Cicero's secretary, Marcus Tullius Tiro (born 103 B.C.) worked out a shorthand system. A military leader Vipsanius (Agrippi), enlarged on the system, which died out after the fall of the Empire. Not much was heard about shorthand until the time of Thomas A. Becket, shortly after 1066, in England, when he revived Agrippi's system. From that time on, numerous men improved upon writing speeds by incorporating wiggly symbols for words. It was not until the advent of the telegraph in the middle of the 19th century that words were abbreviated to carry on communication. Telegraph operators probably sophisticated the most frequently used words on the circuit before the Phillips Code was published. The Phillips Code is probably responsible for a now widely used shorthand method called *stenoscript*, used in business offices by secretaries who do not know the Gregg system of wiggles. Stenoscript could easily be adapted to telegraphy and perhaps the Phillips Code could be speeded up using this method.

Amateur radio operators use some of the words in the Phillips Code. Most amateur transmissions become stereotyped, and the rest of the message can be anticipated before it is finished, making the learning of the abbreviations easy.

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COMMON Q SIGNALS USED BY C.W. OPERATORS

The Q signals below are in common use with c.w. operators. If the Q signal is followed by a question mark, it changes the phrase from a statement to a request or question. Notice the two part definition, first the statement then the question, hence QRP? means shall I decrease power.

QRG	Your exact frequency is . . . . kc. What is my exact frequency?
QRH	Your frequency varies. Does my frequency vary?
QRI	The tone of your transmission is . . . . (1. good; 2. variable; 3. bad). How is the tone of my transmission?
QRK	The intelligibility of your signal is . . . . (1. bad; 2. poor; 3. fair; 4. good; 5. excellent). What is the intelligibility of my signal?
QRL	I am busy, please do not interfere. Are you busy?
QRM	I am being interfered with . . . . (1. nil; 2. slightly; 3. moderately; 4. severely; 5. extremely). Are you being interfered with?
QRN	I am troubled by static. Are you troubled by static?
QRO	Increase power. Shall I increase power?
QRP	Decrease power. Shall I decrease power?
QRQ	Send faster. Shall I send faster?
QRS	Send slower. Shall I send slower?
QRT	Stop sending. Shall I stop sending?
QRU	I have nothing for you. Have you anything for me?
QRV	I am ready. Are you ready?
QRW	Please tell . . . . that I am calling him on . . . . kc. Should I tell . . . . that you are calling him on . . . . kc?
QRX	I will call you again at . . . . hours. When will you call me again?
QRY	Your turn is number . . . . What is my turn?
QRZ	You are being called by . . . . Who is calling me?
QSA	Your signal strength is . . . . (1. barely perceptible; 2. weak; 3. fairly good; 4. good; very good). What is my signal strength?
QSB	Your signal is fading. Is my signal fading? Your
QSD	keying is defective. Is my keying defective?
QSG	Send . . . . messages at a time. Shall I send . . . . messages at a time?
QSK	I can hear you trying to break in between my transmissions; go ahead. Can you hear me trying to break in?
QSL	I am acknowledging receipt. Can you acknowledge receipt?
QSM	Repeat the last message you sent me. Shall I repeat the last message or some previous message which I have sent you?
QSN	I heard you on . . . . kc. Did you hear me on . . . . kc?
QSO	I can communicate with . . . . directly or by relay through . . . . Can you communicate with . . . . directly or by relay?
QSP	I will relay to . . . . Will you relay to . . . .?
QSU	Send or reply on this frequency. Should I send or reply on this frequency?
QSV	Send a series of Vs on this frequency. Should I send a series of Vs on this frequency?
QSW	I a mgoing to send on this frequency. Are you going to send on this frequency?
QSX	I am listening to . . . . on . . . . kc. Will you listen to . . . . on . . . . kc?
QSY	Please transmit on another frequency. Should I transmit on another frequency?
QSZ	Send each word or group twice. Shall I send each word or group more than once?
QTA	Cancel message number . . . . and disregard. Should I cancel and disregard message number . . . .?
QTB	I do not agree with your counting of words, I will repeat the first letter or digit of each word or group. Do you agree with my counting of words?
QTC	I have . . . . messages for you to receive. How many messages have you to send?
QTH	My location is . . . . What is your location?
QTR	The time is . . . . What is the correct time?
QUA	Here is the news of . . . . (call sign). Have you news of . . . . (call sign).

COMMON ABBREVIATIONS USED FOR C.W.

AA	All after
AB	All before
ABT	About
ADR	Address
AGN	Again
ANT	Antenna
BCI	Broadcast interference
BCL	Broadcast listener
BK	Break; break me; break in
BN	All between; been
C	Yes
CFM	Confirm; I confirm
CK	Check
CL	I am closing my station; call
CLD-CLG	Called; calling
CUD	Could
CUL	See you later
CUM	Come
CW	Continuous wave
DLD-DLVD	Delivered
DX	Distance, foreign countries
ES	And, &
FB	Fine business; excellent
GA	Go ahead (or resume sending)
GB	Good-by
GE	Good evening
GG	Going
GM	Good morning
GN	Good night
GND	Ground
GP	Ground plane
GUD	Good
HI	The telegraphic laugh; high
HR	Here; hear
HV	Have
HW	How
LID	A poor operator
MA	Milliamperes
MSG	Message; prefix to radiogram
N	No
ND	Nothing doing
NIL	Nothing; I have nothing for you
NM	No more
NR	Number
NW	Now; I resume transmission
OB	Old boy
OM	Old man
OP-OPR	Operator
OT	Old timer; old top
PBL	Preamble
PSE	Please
PWR	Power
PX	Press
R	Received as transmitted; are
RAC	Rectified alternating current
RCD	Received
REF	Refer to; referring to; reference
RIG	Repeat; I repeat
RPT	Repeat! I repeat
RX, RCVR	Receiver
SED	Said
SEZ	Says
SIG	Signature; signal
SINE	Operator's personal initials or nickname
SKED	Schedule
SRI	Sorry
SVC	Service; prefix to service message
TFC	Traffic
TMW	Tomorrow
TNX	Thanks
TT	That
TU	Thank you
TVI	Television interference
TX	Transmitter
TXT	Text
UR-URS	Your, you're; yours
VFO	Variable-frequency oscillator
VY	Very
WA	Word after
WB	Word before
WD-WDS	Word; words
WKD-WKG	Worked; working
WL	Well; will
WUD	Would
WX	Weather
XMTR	transmitter
XTAL	Crystal
YF (XYL)	Wife
YL	Young lady
73	Best regards
88	Love and kisses

To show the similarity between Phillips Code, Stenoscript, and radio amateur operator abbreviations a few words have been selected at random:

	Amateur	Phillips	Stenoscript
About	ABT	ABT	ABWT
Again	AGN	AGN	AG
Break	BK	BK	BA
Could	CUD	CD	kd
Distance	DX	DSC	dS
And	ES	ES	a——
Good	GUD	GD	gd
Now	NW	NW	nw
Please	PSE	PLS	pz
Thanks	TNX	THK	——q
Your	UR	UR	u
Would	WUD	WD	wd

For those who are interested, further books can be obtained on the subject.[1]

A typical radio amateur transmission might look like this:

> W6XXX de W6ZZZ BT RR OK OM UR SIGS FB HR IN PODUNK BT UR SIGS 599X BT RCVG U ON A HOME BREW RCVR RIG HR 40 WATTS TO DIPOLE ANT BT TNX FER CTC ES QSO BT WX CONDX HR FB BUT OVRCST BT QRU 73 CUL BT W6ZZZ DE W6XXX AR SK K

Translated might mean:

> W6XXX DE W6ZZZ—Message received OK old man your signals fine business here in Podunk—Your signal readability perfect signal strength extremely strong tone purest d.c. note sounds like crystal oscillator—Receiving you on a home made receiver, transmitter forty watts to a dipole antenna—Thanks for the contact and conversation—weather conditions here fine but overcast—I have nothing further for you best regards see you later—W6ZZZ DE W6XXX End of transmission signing off go ahead and transmit to me.

Radio amateur's abbreviations are flexible, there is no set rule. Many operators make up their own abbreviations as they go along. After a short time on the air operating, even the beginner can understand the abbreviations.

The best way for the beginner to learn is by keeping a list of the abbreviations by the key for reference. It does not take long to become familiar with most of the frequently used abbreviations. Abbreviations are actually what make c.w. operating fun! ■

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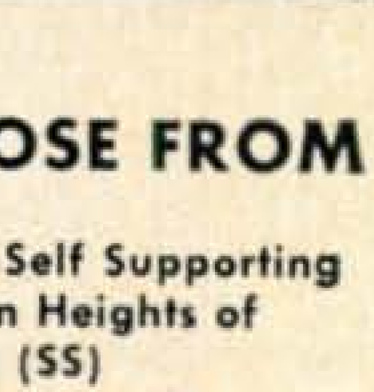
[1] *Stenoscript* by Manuel C. Avancena, Stenoscript Inst., 1609 Pine Ave., Long Beach, California.
The Phillips Code by W. P. Phillips, Telegraph and Telephone Magazine, Beaver Street, New York City 4, N.Y. (Also given out by the Vibroplex Co.).
ARRL Handbook p. 558, p. 591, 1965 Edition. American Radio Relay League, West Hartford, Conn.
Shorthand Systems of the World by Hans Glatte, Philosophical Library, Inc., 15 East 40th Street, New York.
Military "Z" signals, ACP 131 (B), Communication Instructions and operating signals, July 1964, Joint Chief of Staff. (unclassified)



Results of the May 1966 CQ *Twelve-Hour V.H.F. Contest*

BY ROBERT M. BROWN,* K2ZSQ

AFTER being rather intensely involved with v.h.f. contests of one sort or another over the last eight years, you might suspect by now I'd have some well-based suggestions on what it takes to win. To be perfectly frank, I have always been proud of my theories. That is, until now. The May 7th 12-hour v.h.f. contest has left at least this one writer visibly shaken. One conclusion we've developed over the years is that it usually seems to be the one-shot enthusiasts—the fellows who come from nowhere to go all out for a particular contest—who seem to get all the glory. The regular contestants, on the other hand, have seldom risen above third or fourth place in their states. On that second Saturday in May, though, W1UDT, W2NNL, K3AKR, W3WFM, K4BEI, K4EJQ, K9OYD, K9RVG, and a host of others destroyed that illusion once and for all by becoming certificate winners, in spite of all that dyed-in-the-wool experience.

The First Time for Clubs

The advent of a club aggregate category *twice* annually in *CQ* v.h.f. contests had a few of us wondering if the major v.h.f. groups would bother to turn out for both. Needless to say, we were pleasantly surprised at the healthy crop of clubs whose members decided to contribute their May point-totals. As promised, the *CQ* Twelve-Hour VHF Contest High Honors Trophy has been engraved with the name of the first club to win it: The Midwest VHF-UHF Amateur Association, of Illinois. Their score of 252,304 put them way out in front, revealing a magnificent effort on the part of members, and, incidentally, marking the first time that such a presentation has been made to a v.h.f. society outside the traditional "winning-grounds of the east."

The Novice Meet

In this classification, too, the midwest continued to dominate the scene. The national winner this time was WN9RNQ whereas last year the award went to WN2RRS.

To those who contend that crystal-controlled "beginners" lack contesting skill, let us call your attention to WN3FIH (Md.) and WN3FLN (Penn.) who, in addition to entering the Novice meet, placed first in their states on 144 mc. Our congratulations!

Jack Mackner, W8PSX, of Westlake, Ohio.

Here's the shack of WB2BXX (at right) with WB2KTO on the left.

Phil, WB2MRK, entered the contest from Florida with the call WA4AIG.

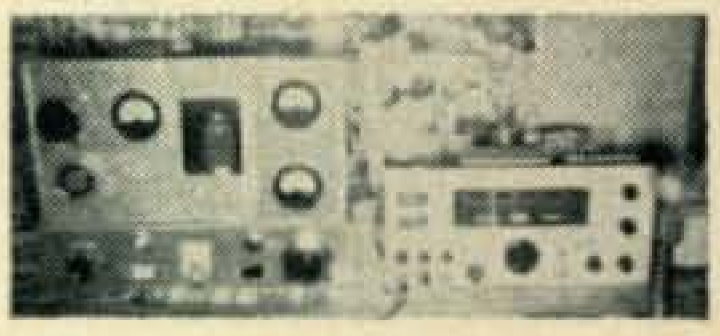
Our lone entrant from Hawaii on 6 was KH6FNW.

WA1DPX/1 on Mt. Agamenticus, Me.

Here's Joe, WA2MGA, operating WA2VLR.

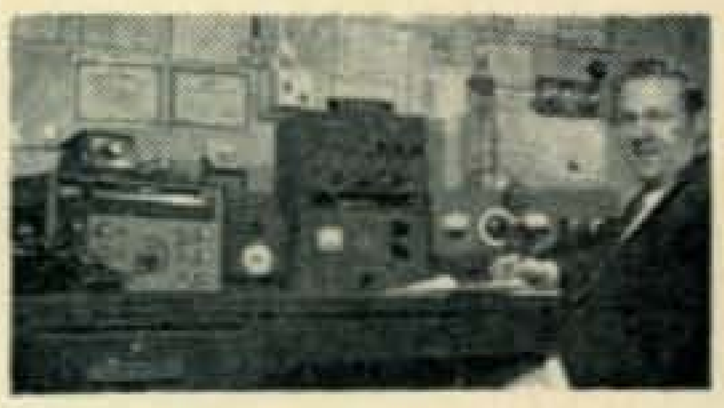
K3RBH (l) and K3CXZ (r) on top of Mt. Davis, Pa.

Merl, K8EFS, of Charlotte, Mich.



The rig that gave K9DZK Indiana.

K4BEI operated from Cheaha Mt., Ala.



K9RVG of Chicago.

Ed, WB2OAB, of Carteret, N.J.

"Bunky" Botts, K4EJQ.

Verla, WN8SYZ, of Detroit.

K7ZFG (l) and K7GWE (r) on snow covered Larch Mt., Oregon.

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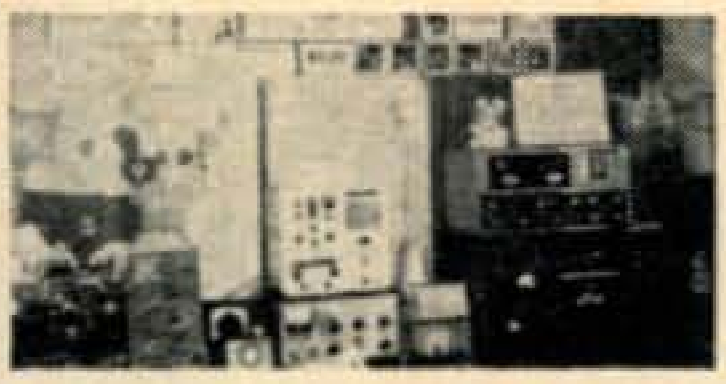


The Novice award winning shack of WN9RNQ.

Al, WA0IKJ, of Jackson County, Mo.

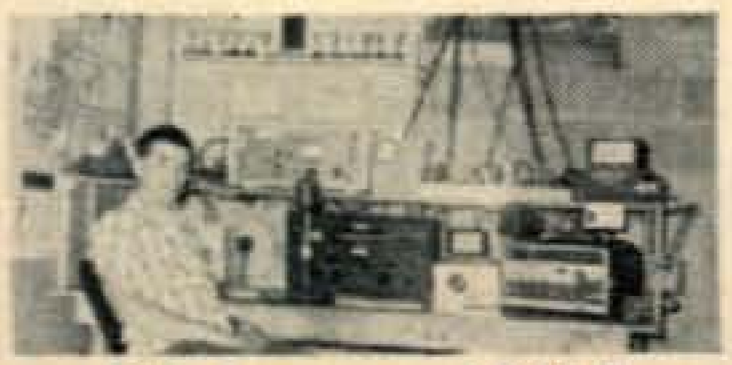
WA3BKP of New Hope, Pa.

Terry, K3LNZ, put Washington, D.C. on the map.

WN3FLN of Avalon, Pa.

Dick, K1QKV, of Ridgefield, Conn.

Jim Novak, WA9FIH, of Illinois.



Sid Emmons, K8ZES.

HIGH SCORES

Six: WA8OLW	288,864
Two: K6JHV/6	114,264
Novice: WN9RNQ	39,780
Club: Midwest VHF-UHF Association	252,304

Comments—Six Meters

W1ADZ/1—Twelve hours is a good deal. We were on Mt. Greylock, and the wind, sleet and snow tended to keep things cool . . . *WB2QZZ/2*—The contest was great. Enjoyed it tremendously. Am building a 25-watt rig for August . . . *K3SZH*—First time K3EGK and I joined in a contest and went all the way. Local activity was horrible . . . *W4ZIL*—Lack of band opening caused low score.

WA5IYX—No *E*s openings at all. Some groundwave, but antenna too low to get it . . . *W6SD/6*—Suggest plaque or trophy to top eastern and western club entry to pull more clubs into the competition . . . *K7NOS*—Band very dead here . . . *WA8KCX*—Had a lot of fun and worked a lot of good groundwave . . . *WA9CWE*—Enjoyed the contest and looking forward to the next . . . *WA0IKJ*—Band opened three times during contest, but not long enough to make contacts . . .

Comments—Two Meters

W1DZA—Worthwhile contest! Plenty of QSB on W1's, but lacking a good tropo opening . . . *WB2RUH*—Scarce activity in Philadelphia area made us fight for all contacts . . . *WN3FIH*—Wish there were more! . . . *W4GFY*—Be encouraged to continue contest. This contest time limit, band limit and county multiplier are a strong inducement to the single-band operator . . . *W5BMT/5*—How about another contest in late summer or early fall? We need something around here to wake up the 2-meter gang . . . *K6HPR/4*—Was all set to go up to Sugar Loaf Mtn., but chickened out on carrying a big 12-volt battery a quarter-mile up the hill. Maybe next time . . .

K7ZFG/7—Score lower than normal due to regional MARS conference, and good driving weather! . . . *W8KKF*—Heard Michigan and Kentucky stations, but they were in and out real quick . . . *WN9QZE*—First contest I've entered, and think it's a lot of fun, even with just the five watts I'm running on two . . . *K0EZH*—Like the 12-hour duration much better than 24 or 48. In my estimation, scoring is as nearly perfect as it can be.

Club Scores

Midwest VHF-UHF A. Assoc. (Ill.)	252,304
Germantown R. C. (Pa.)	170,758
Peninsula Amateur Radio Klub (N.J.)	126,720
Cleveland 50 Mc DX Club (O.)	110,088
Berkshire County VHF & Booze Society (Mass.)	96,288
Nat'l. Award Hunters Club (Mass.)	68,040
VHF Hillbillys (Pa.)	67,200
San Fernando Valley R.C. (Calif.)	40,512
Burlington A.R.S. (N.J.)	40,296
Lawndale Chicago Boys Club A.R.A. (Ill.)	33,471
The Six Meter Club of Dallas (Tex.)	32,664
Metuchen YMCA R.C. (N.J.)	29,412
Edison R.C. (N.J.)	29,412
Audubon A.R.C. (N.J.)	23,901
Queen City Emer. Net, Inc. (O.)	19,980
Colonial Central H.S. R.C. (N.J.)	18,720
Case Tech A.R.C. (O.)	13,104
Veterans Admin. R.C. (Ill.)	10,800
Plymouth A.R.C. (O.)	10,354
The Six & Two Ham Club of Chicago (Ill.)	6992
Maury County R.C. (Tenn.)	4728
Warminster A.R.C. (Pa.)	3456
Grayslake Community H.S. A.R.C. (Ill.)	3168
Bloomfield H.S. A.R.C. (N.J.)	2085
North Little Rock A.R.C. (Ark.)	240
Six Meter Club of Chicago (Ill.)	198
Shawnee A.R.A. (Ill.)	60

WB2PMP, of Oceanside, L.I.

Gary, K1YLU, along with Kerry K1VPD nearly froze atop Mt. Wachsusett, Mass.

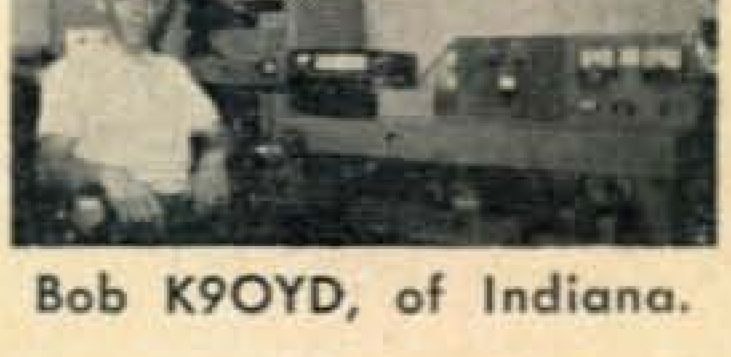
WB2QLP of Long Beach, L.I.

The two man team of WB2WJV (l) and WB2TGT

K2QPN of N.J.

Phil Miller, W3WFM, of Maryland.

Mat, WA9FYB, of Illinois.



Bob K9OYD, of Indiana.


Len, WB2SQS.


Ian Campbell, WN5OFT, of Little Rock, Ark.


Dan Swanner, WN3FIH, of Silver Spring Md.


Bill, WA5LGH, the lone two meter entrant from Texas. He is a C.P.O. in the Coast Guard.

50 Mc Results

The number groups after the call letters denote the following: number of contacts; number of counties; hour multiplier; power multiplier and final score. The other competition classifications follow suit.

Alabama

K4BEI/4	63	28	12	2	42,336

Arizona

K7PRS/7	20	3	9	3	1620
K7NOS	20	1	12	3	720
WA7ETX/7	1	1	1	3	3

Arkansas

WA5MXI	4	2	4	2	64

California

WA2SAB/6	86	21	12	3	65,016
W6NLO/6	21	5	9	3	2835
W6SD/6	23	5	5	2	1150

Colorado

W0HEP	3	3	2	3	54

Connecticut

K1MRI	158	45	12	2	170,640
K1TLA	35	13	8	3	10,920

District of Columbia

K3LNZ	49	21	12	2	24,696

Florida

WA4AIC	82	28	12	3	82,656

Georgia

K4ZMQ	52	27	10	2	28,080

Hawaii

KH6FNW	12	1	6	2	144

Illinois

WA9FIH	73	6	12	3	15,768
WA9FYB	42	6	12	3	9072
WA9EJE	57	5	12	2	6840
W9DJZ	38	7	12	2	6384
K9YHB	43	4	12	2	4128
WA9CUK	43	4	11	2	3784
WA9DOA	22	9	8	2	3168
WA9PAI	39	4	10	2	3120
WA9AIS	24	3	8	3	1728
WA9EJD/9	20	3	5	3	900
W9ZSQ	19	2	8	2	608
W9VWY	11	4	4	3	528
WA9AIJ	15	2	6	2	360
K9DKI	12	2	2	3	144
K9VLX/9	16	1	3	3	144
W9KYA	13	2	1	3	78
K9RHY/9	12	2	1	3	72
K9RCN	5	1	3	3	45
K9DZX	9	2	1	2	36
K9ZWU	5	2	1	3	30
K9QYT	8	1	1	3	24
WA9FIH/9	4	1	2	3	24
K9RHY	3	1	2	3	18
WA9AIS/9	2	1	1	3	6

Indiana

K9DZK	83	38	12	1	37,848
WA9CWE	48	13	12	2	14,976

Maine

WA1DPX/1	80	14	12	3	40,320

Maryland

W3WFM	42	27	12	3	40,824
W3JZY	52	28	8	2	23,296
K3ICH	47	16	12	2	18,048
K3ZSX	35	13	12	2	10,920
W3TBF/3	26	11	10	2	5720

Massachusetts

K1YLU/1	112	39	12	2	104,832
W1ADZ/1	68	28	12	2	45,136
K1ZGH	11	7	5	2	770

Michigan

K8EFS	40	19	12	2	18,240
K8VEX	44	25	12	1	13,200

Missouri

WA0IKJ	43	6	12	3	9288

New Jersey

WA2VLR	110	48	12	2	126,720
WA2WZP	122	37	12	2	108,336
K4HAV/2	82	29	12	3	85,608
WA2BXK	100	27	12	2	64,800
WB2QZZ/2	43	19	12	3	29,412
WA4QLB/2	58	19	11	2	24,244
K2QKV	20	17	11	3	11,220
WB2OYK	13	8	12	3	3744
WB2MJF/2	13	8	6	3	1872

New York

WA2LPG/2	69	31	12	3	77,004
WB2PMP	89	26	12	2	55,536
WB2QLP	45	16	12	3	25,920
WA2DNR	40	13	12	3	18,720
WB2OIM	50	12	12	2	14,400
WB2RBG	44	11	12	2	11,616

North Carolina

WA4YIU	53	21	12	3	40,068
WA4WZP	29	15	12	3	15,660
K4VCQ	31	17	8	3	12,648
WA4WZQ	31	16	11	2	10,912

Ohio

WA8OLW	136	59	12	3	288,864
WA8EHI	139	33	12	2	110,088
WA8LXJ	72	20	12	3	51,840
WA8POU	55	13	12	3	25,740
W8JRN	50	13	12	2	15,600
WA8KCX	29	9	12	3	9396
W8KKF	11	6	1	2	132

Pennsylvania

K3AKR/3	99	50	12	2	118,800
K3DUW/3	82	40	11	2	72,160
K3LNU/3	80	28	10	3	67,200
WA3BKP	53	27	12	3	51,516
K3ZPG	82	20	12	2	39,360
W3JMP	51	19	12	2	23,256
K3ZSU	43	21	10	2	18,060
K3SZH	44	29	12	1	15,312
WA3BCD	25	16	4	3	4800
WA3BGN	4	3	4	3	144
K3DVS/3	4	3	2	3	72

Tennessee

WA4YKN	51	23	12	2	28,152
WA4CGA	32	19	12	2	14,592
WA4PZB/4	19	8	12	2	3648

Texas

K5IVB	59	8	12	2	11,328
WA5JTM	48	6	11	3	9504
WA5LPA	49	7	12	2	8232
WA5OMG	40	5	9	2	3600
W4ZIL/5	20	7	12	2	3360
WA5IYX	9	2	8	3	432
K3UXA/5	3	1	2	3	18

Virginia

K4FJW/4	14	10	9	3	3780

Washington

K7BBO	72	11	12	3	28,512
WA7BTG	41	5	12	3	7380

West Virginia

W8WEJ	13	4	9	3	1404

Canada

VE3CGD	16	2	11	3	1056

144 Mc Results

Arkansas

W5BMT/5	6	4	5	2	240
WN5OFT	5	3	5	3	225
WN5OVZ	2	2	1	3	12

California

K6JHV/6	138	23	12	3	114,264
WA6TGH/6	205	8	12	2	39,360
W6NLO/6	47	6	12	3	10,152
WB6RWF	40	4	12	3	5760
W6SD/6	1	1	1	2	2

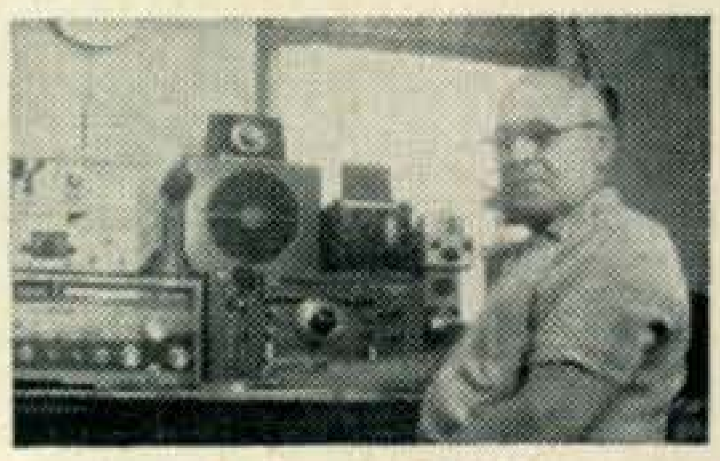
Colorado

W0WYX	44	12	12	3	19,008
K0EZH	36	8	11	3	9504
W0HEP	7	4	2	3	168
W0HEM	6	4	1	3	72

Bill, WN2VUE.


Ken Rushing, WA5LPA, Pres., of the Six Meter Club of Dallas.


Kirk Fourcher, K1MRI, of Ridgefield, Conn.


Andy, W3JZY.

Connecticut

K1PXE	119	29	12	2	82,824
WA1DQL	109	27	12	2	70,632
K1QKV	66	24	12	3	57,024
WA1CYM	32	12	11	3	12,672
W1DZA	26	6	11	3	5148
W1QJL	10	4	2	3	240

Illinois

K9RVG	111	25	12	3	99,900
W9ZFZ/9	88	17	12	3	53,856
W9VWY	78	19	12	3	53,352
WN9RNQ	65	17	12	3	39,780
WA9OMM	47	10	12	3	16,920
K9WFN	60	9	10	2	10,800
WA9ERH	44	8	9	3	9504
WA9OBQ	33	7	11	3	7623
WA9JKT	30	8	10	3	7200
WA9RHR	27	11	12	2	7128
WA9MSZ	35	6	11	3	6930
WA9PDI	35	4	11	3	4620
W9IJF	17	10	11	2	3740
WN9QZE	12	4	6	3	864
WA9HIV	18	2	3	3	324
W9YOW	12	2	3	3	216
WA9FIH	6	1	4	3	72
WA9HAB	5	2	2	3	60
WA9AAQ	4	2	2	3	48
WA9GVF	4	1	2	3	24

Indiana

K9OYD	62	18	12	3	40,176
WA9CWE	19	7	12	3	4788
WA9IVB/9	16	10	9	2	2880
WN9QGT	14	5	8	3	1680

Maine

WA1EFN/1	55	14	12	3	27,720
K1UMZ	15	7	9	3	2835

Maryland

WN3FIH	36	12	12	3	15,552

Massachusetts

W1UDT/1	68	31	12	2	50,592
K1RCD	28	10	12	3	10,080
W1BVV	2	2	2	3	24

Michigan

K8LZL	50	25	12	2	30,000
WN8SYZ	42	7	12	3	10,584
WA8NEH	41	9	12	2	8856
WA8MJY	27	9	6	3	4374

New Jersey

W2NNL	120	27	12	2	77,760
K2QPN	73	23	12	2	40,296
WB2OAB	43	15	12	3	23,220
WB2TGT	51	16	12	2	19,584
WB2SZK	32	10	11	3	10,560
WB2RUH	27	9	10	3	7290
WN2UVB	24	7	12	3	6048
WB2VFX	19	8	12	3	5472
WB2MJF/2	13	8	7	3	2184
WB2FLU/2	15	9	5	3	2025
WB2PZB	20	10	4	2	1600
WB2STR	7	4	5	3	420

New York

WB2DIN	85	20	12	3	61,200
WB2SQS	81	20	12	3	58,320
WB2QLP	65	17	12	2	26,520
W2IYW	96	23	12	1	26,496
WN2VUE	39	15	12	3	21,060
WB2OTM	37	16	12	2	14,208
WN2VTP	40	8	9	3	8640
WB2OIM	29	7	12	3	7308
WB2OUK	18	6	5	3	1620
W2IP	14	10	3	3	1260

North Carolina

WA4WZQ	5	5	5	3	375

Ohio

W8PSX	45	19	11	3	28,215
W8VND	37	15	12	3	19,980
K8ZES	33	21	12	2	16,632
W8EDU	39	14	12	2	13,104
W8KKF	38	14	11	2	11,616
K8TSC	25	18	11	2	9900
K8HVA	26	17	11	2	9724
WA8SOK	30	12	12	2	8640
K8IIA	7	5	6	3	630

Oregon

K7ZFG/7	35	7	12	3	8820
WN7DZK	13	2	8	3	624
W7JRI	10	2	6	3	360
WN7DXN	3	1	1	3	9

Pennsylvania

WN3FLN	22	8	8	3	4224
WA3DFU	12	8	12	3	3456
K3DVS/3	13	10	7	3	2730
K3ZSU	4	4	3	3	144
K3DUW/3	5	4	2	3	120

Tennessee

K4EJQ/4	36	11	12	2	9504
WA4PZB	12	3	10	3	1080

Texas

WA5LGH	4	3	4	3	144

Vermont

K1GYT	18	6	8	3	2592

Virginia

W4GFY	12	7	8	3	2016
K6HPR/4	10	5	9	3	1350

Wisconsin

WA9MCC	14	4	9	3	1512

Wyoming

W7SQT	1	1	1	3	3

Canada

VE3ASO	53	13	12	3	24,804
VE3DDO	37	6	12	3	7992

432 Mc

K2ACQ	12	5	8	3	1440
VE3EZC	7	4	4	3	336
WA4CGA	3	1	1	3	9

Novice Results

WN9RNQ	65	17	12	3	39,780
WN2VUE	39	15	12	3	21,060
WN3FIH	36	12	12	3	15,552
WN8SYZ	42	7	12	3	10,584
WN2VTP	40	8	9	3	8640
WN2UVB	24	7	12	3	6048
WN3FLN	22	8	8	3	4224
WN9QGT	14	5	8	3	1680
WN9QZE	12	4	6	3	864
WN7DZK	13	2	8	3	624
WN5OFT	5	3	5	3	225
WN5OVZ	2	2	1	3	12
WN7DXN	3	1	1	3	9

Power Versus Efficiency Modulation

BY CARL C. DRUMELLER,* W5EHC

The author explains the theory and practice for both types of modulation in the article below and compares the good and bad points of each system.

In the field of amplitude modulation, there are two broad categories: "Power" modulation and "Efficiency" modulation. Each is used extensively in both commercially-manufactured and amateur-built transmitters. Each has merit and each has certain debit factors. The purpose of this article is to discuss the salient points of each system so as to permit the reader to reach a decision as to which system more nearly satisfies his requirements.

A. M.

First, it would be well to think a bit about amplitude modulation. It has one unique advantage. On all the systems used (amplitude, frequency, pulse position, pulse width, pulse jitter, *etc.*), amplitude modulation is the only one that does not require a close mating of the characteristics of the receiver with the characteristics of the transmitter. This unique advantages permits a flexibility of application that has, rightfully, made amplitude modulation the dominant mode used in radiotelephony. (Single-sideband suppressed-carrier radiotelephony may be classified as a specialized application of amplitude modulation.)

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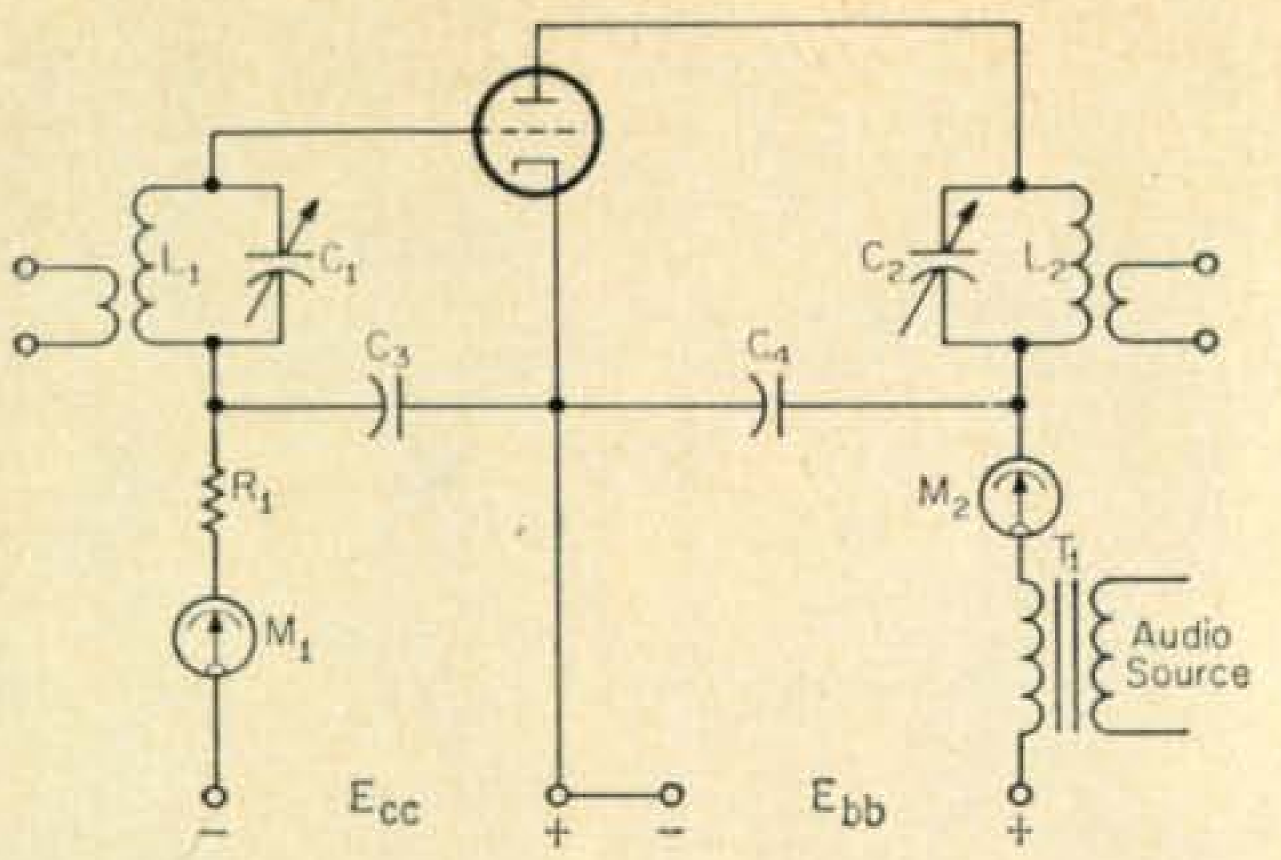

Fig. 1—Circuit illustrating the basic power-modulator.

Modulation Types

The process of modulation is a process of mixing or heterodyning. The full treatment of this subject is beyond the scope of this article. It is strongly urged that the reader, if he truly is interested in the subject, read Chapter 10, in Principles of Applied Electronics.[1]

It is conventional to speak of amplitude modulation in terms of carrier, upper sideband, and lower sideband. In this convention, it is said that the direct-current power supply of the modulated stage furnishes the power to produce the carrier, and the modulator furnishes, in the case of power modulation, the energy to produce the upper and the lower sidebands. In the case of efficiency modulation, all the power (for carrier and sidebands) must come from the direct-current power supply of the modulated stage.

These common statements are true to a limited extent. They do not, however, present the complete picture. For that, the reader is referred to Carson's very excellent treatment. In this article, the commonly-used convention will be followed.

Power Modulation

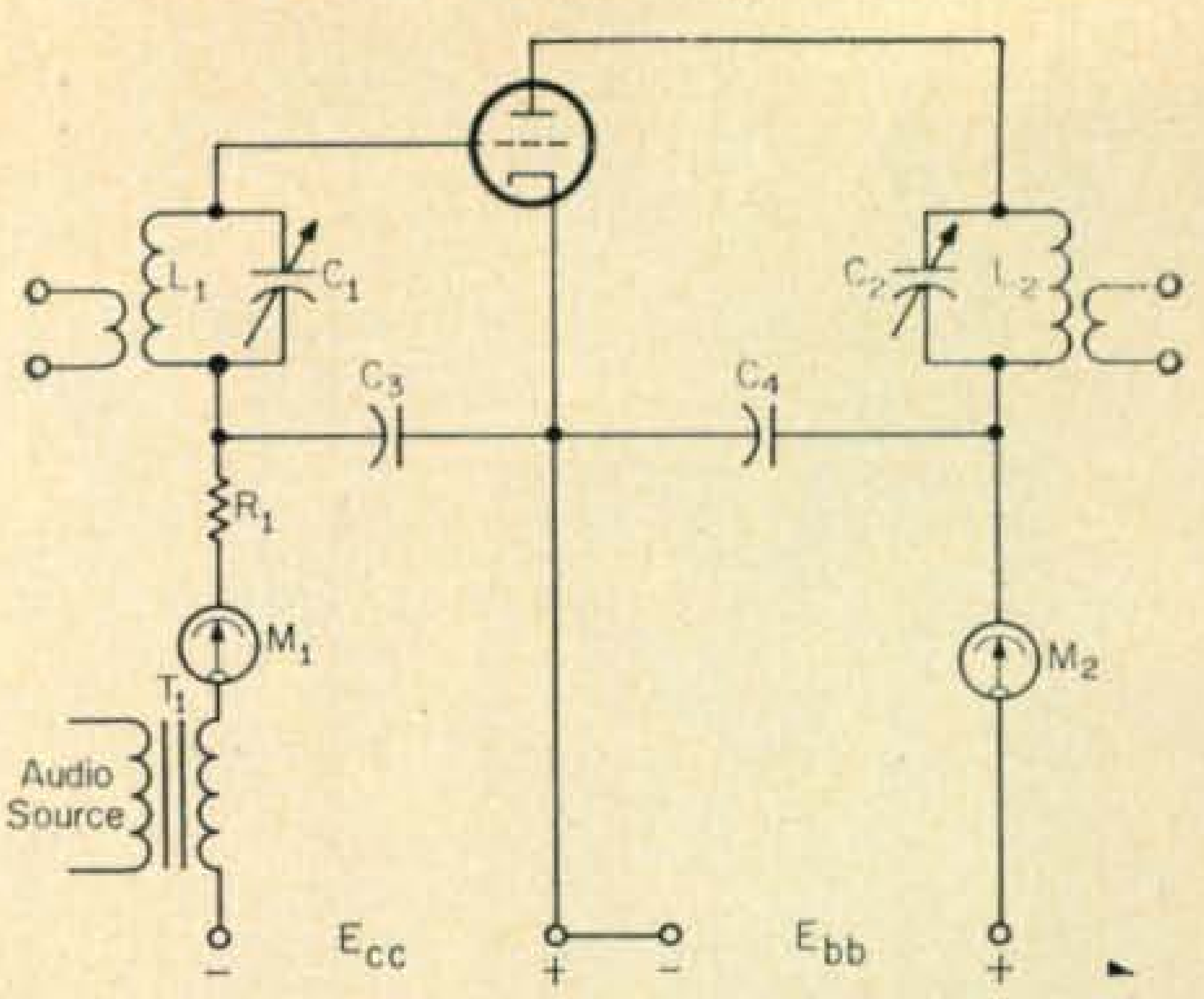

Fig. 2—Circuit illustrating efficiency modulation.

Power modulation, being perhaps the more common and certainly the more basic, will be considered first.

In fig. 1 a simplified diagram of a modulated radio frequency power amplifier stage is shown. To reduce complication, a triode stage is used; for further simplification, neutralization is omitted. This stage is made to operate Class C; that is, its parameters are so juggled that the direct-current plate current of the vacuum tube will vary in exact proportion with the direct-current plate voltage of the tube. This being an important point, it will be illustrated with an example. If the normal plate voltage were 1000 volts and the normal plate current were 0.1 amperes, then if the voltage is increased to 2000, the current will increase to exactly 0.2; if the voltage is decreased to 500, the current will decrease to exactly 0.05. This relationship should hold precisely over the range from zero plate voltage to twice the normal plate voltage. This condition is achieved by the use of a tube with ample cathode emission, by supplying a general amount of radio-frequency input (grid) power, by adjusting the total grid bias to a value of approximately twice the amount required to cut the plate current to zero, and by loading the plate circuit to a point low enough to permit the plate power input to go to a value four times as great without exceeding the capabilities of the tube or its total

Power Modulation	Efficiency Modulation
1. Contributes extra power to signal intelligence.	1. Contributes no additional power to signal intelligence.
2. Operates at constant conversion efficiency.	2. Operates at varying conversion efficiency.
3. Initially adjusted to high degree of conversion efficiency.	3. Initially adjusted to moderate degree of conversion efficiency.
4. Requires power-consuming and expensive modulator.	4. Requires small and inexpensive modulator.
5. Very tolerant of tuning and loading adjustments.	5. Very demanding of precise and difficult-to-evaluate tuning and loading adjustments.
6. Easily designed to modulate at 100% level.	6. Very difficult to design so as to modulate at 100% level without serious distortion.
7. Requires high radio frequency drive level.	7. Requires moderate radio-frequency drive level.
8. Requires "stiff" plate voltage source.	8. Requires moderately "stiff" plate voltage source.
9. Requires moderately "stiff" grid-bias source.	9. May require "stiff" grid-bias source.
10. Modulator may weigh more than r.f. section.	10. Modulator very light.
11. Easy to monitor modulation quality with simple equipment.	11. If combined with controlled-carrier, almost impossible to monitor modulation quality except with a spectrum analyzer.

Table 1—Comparison of power and efficiency modulation.

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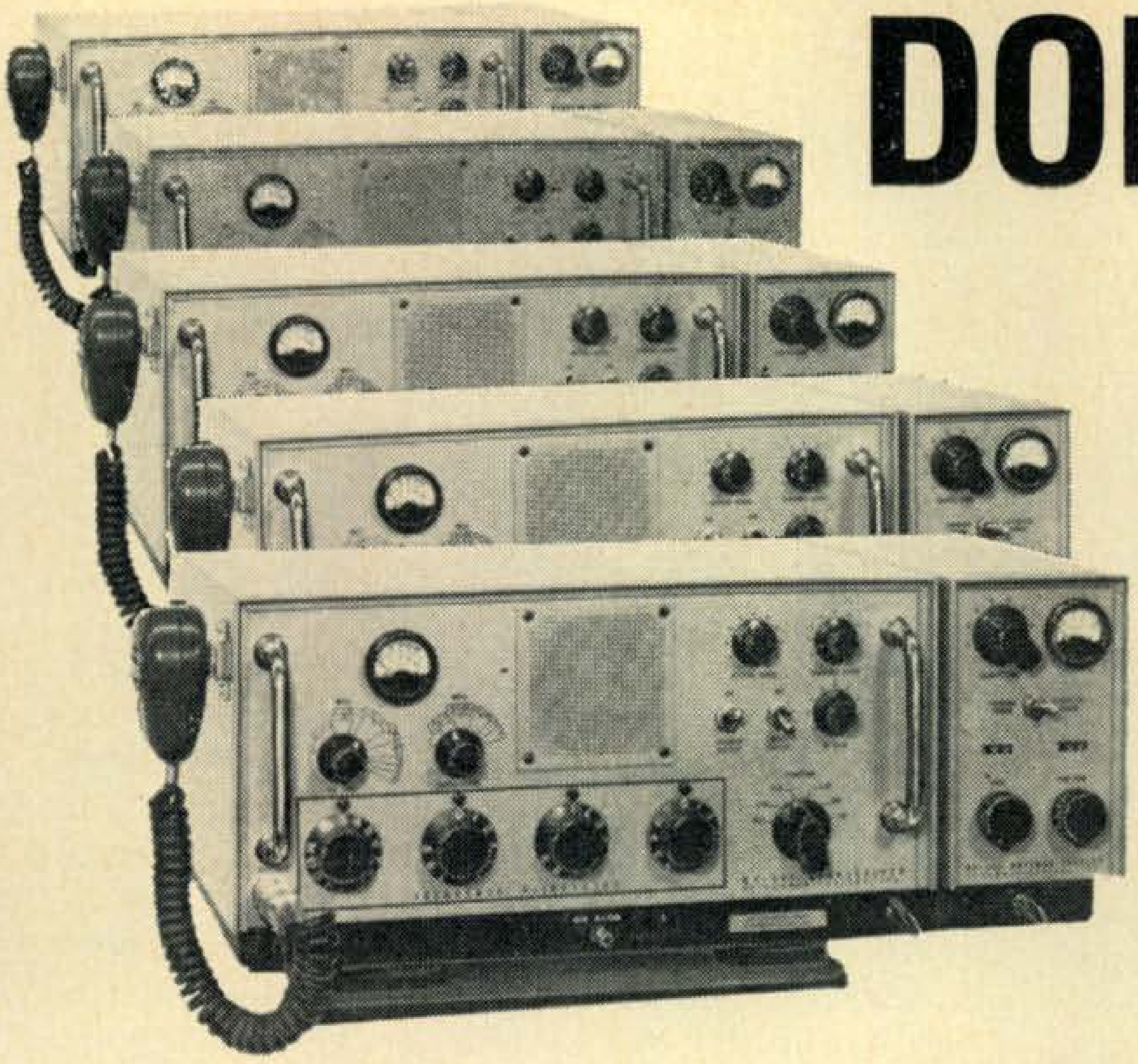
[1] Carson, Ralph S., *Principles of Applied Electronics*, McGraw-Hill.



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Over 500 RF-301 SSB Transceivers are in use throughout the world at the present time. Users include the U. S. Navy, U. S. Coast Guard, U. S. Air Force, Army and other military groups in many foreign countries. Important communication systems both vehicular and fixed station employing RF-301 transceivers exist in Australia, Brazil, Belgium, South Africa, Chili, Kenya, Great Britain, Ivory Coast, Iran and many other countries. It has been combat tested under tactical operating conditions by actual use.

The RF-301 is intended to be used in vehicular application, in shelters, in boats or for fixed station use. Both AC and DC operation are possible and an extremely flexible antenna coupler system permits it to be operated with any random antenna from a nine foot whip to a 150 foot long wire. A remotely operated model of the coupler is available for fixed station operation. The RF-301 is designed for operation in any environment from the Tropics to the Arctic region and for communication ranges from close in to several thousand miles.

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Frequency Range: 2 to 15 Mc.

Synthesizer: Can be tuned to 1 KC. increments or continuously with 100 cycle calibration.

Power Output: 100 watts p.e.p. and average.

Stability: 1 part, 10^6 standard, 5 parts 10^8 optional.

Modes: USB, LSB, AM, CW. Also FSK with adapter.

Power Input: 115/230 volts, 50/60 cycles standard. 12 or 24 volt DC with additional built-in module.

Size: 7¾ x 17 x 14¾ inches.

Weight: 59 pounds.

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plate power supply system.

The tube, then, is prepared to do a dual job of converting. It will convert direct current power (from its total plate power supply) into radio-frequency energy; it will convert (mix or heterodyne) the two input signals (radio-frequency at its grid, audio-frequency at its plate) into sum-and-difference signals. The two original signals remain present, too. The tuned circuit, L_2C_2, rejects one of these (the audio frequency), and the remaining original signal (the radio frequency) is accepted by the tuned circuit. It, plus the sum-and-difference signals, constitute the radio-frequency output of the modulated stage. You'll recognize these as the familiar carrier (original), upper sideband (sum), and lower sideband (difference).

Sideband Power

Now, let's see how this power function gets into the picture. Remember that we said we'd assume that the plate current was 0.1 ampere and the plate voltage was 1000. This constitutes an input of 100 watts. If the circuit operated at 70% efficiency, the radio frequency power output would be 70 watts. Now, let us further assume that the associated modulator is capable of supply 50 watts of sine-wave output, measured at the secondary of the modulation transformer. This is the amount required for 100% modulation. With the modulator functioning, the total plate power input is not 100 watts but 150 watts. Still assuming 70% efficiency, this means that the total radio-frequency power out now is 105 watts. This extra 35 watts represents the power contained in the signal intelligence, the sidebands.

From the foregoing, there are two facts to be noted and retained for further consideration: 1. The modulator supplied the power for the production of the signal intelligence, and 2. The efficiency of the stage for converting plate power input into radio-frequency power output remained constant.

Efficiency Modulation

Now, let's take a look at fig. 2, which shows one of the many forms of "efficiency" modulation: this particular one is control-grid modulation. It was selected solely because its diagram is very similar to that used for the "power" modulated stage. The principles involved are the same, regardless of whether control-grid, screen-grid, or suppressor-grid modulation is concerned.

This principle can be simply stated: A stage is adjusted initially so that its efficiency (the ability to convert direct-current plate power into radio-frequency power) is only moderate; then this efficiency is varied at an audio rate. The variation of efficiency shows up as increased or decreased radio-frequency power output, which constitutes the signal intelligence. Incidental to this variation of efficiency, there occurs the inevitable mixing of radio frequency and audio frequency signals. This, of course, produces sum-and-difference signals, just as in the case of "power" modulation. Therefore the output of an "efficiency" modulated transmitter has identical characteristics as that of a "power" modulated transmitter.

The exact process whereby the conversion efficiency is varied depends upon the configuration of the modulated stage. For the stage shown in fig. 2, the conversion efficiency is related to the angle of conduction in the plate circuit, which, in turn, is related to both control-grid bias and control-grid radio frequency drive. Assuming the latter to be constant, the former may be considered to vary at an audio-frequency rate, thus effecting the desired modulation of conversion efficiency.

Similarly, the screen grid or the suppressor grid may serve as the element controlling the conversion efficiency. Sometimes combinations of these elements are used. An appreciable advantage is realized by simultaneous use of both the control grid and the screen grid.

When the plate, the control grid, the screen grid, and the suppressor grid are all modulated simultaneously, the system is called "cathode modulation." Its chief claim to fame lies in its ability to combine all the undesirable attributes of each of the individual systems while *avoiding* the desirable features of any one.

Because of the necessity of limiting the steady-state efficiency of the stage (so that it may be "modulated up" as well as "modulated down"), there have been many schemes proposed for increasing the overall effectiveness of efficiency modulation systems. Almost all of these take the form of some method of controlling the power of the carrier, allowing it to run at a quite low level during periods of no modulation and advancing in proportion with the applied modulation. Usually this is accompanied by considerable distortion; by careful adjustment and judicious use of the audio-frequency gain control, this distortion can be held to a level acceptable by the non-critical.

Adjustments

All forms of efficiency modulation (with suppressor-grid the least offensive) require quite precise adjustment of all parameters in order to operate effectively. Of all the variables left to operator manipulation in manufactured transmitters, plate loading is the most demanding. Quality deteriorates sharply if the loading is either too heavy or too light.

Please note that in this article there has been a careful effort made not to equate "power" modulation with "plate" modulation. Although it is true that the most common form of plate modulation is also power modulation, it is quite possible to effect plate modulation by the efficiency method. This is quite common in pulse circuits, including television.

Having considered both "power" and "efficiency" modulation systems, the next step is a tabulation of the attributes of each system. This will permit the reader to make a ready evaluation and thus determine which one meets his needs. Table 1 presents this tabulation. ■

A PRODUCT DETECTOR FOR THE 75A-4

BY CARL EBHARDT,* W4HJZ

With the advent of more and more s.s.b. activity on the ham bands it became desirable for the author to modify a Collins 75A3 to incorporate a product detector. A search of the ham magazines was made to determine what had been published about product detectors and in particular product detectors for the popular 75A series receivers. The only article that really applied to the problem at hand was in *CQ*.[1]

The circuit referenced was constructed and found to be deficient in several areas. The major problem was that in s.s.b. mode the b.f.o. voltage got into the diode detector, generating a large a.v.c. voltage which controlled and reduced the receiver gain. Only the strongest of signals could be copied. In addition, the design was such that the n.b.f.m. mode was sacrificed to obtain an s.s.b. mode. The a.v.c. in a.m. mode was slow release.

A new circuit was designed that solved all of these problems. A product detector circuit similar to the dual triode circuit shown in the ARRL Handbook was chosen because it provided isolation of b.f.o. and i.f. signals. It was combined with other necessary switching and time constant circuits to provide a complete four mode receiver.

The modifications described in this article yield a 75A3 that retains all the original characteristics in the c.w., a.m. and f.m. modes (except that the a.v.c. is fast attack in a.m. mode). A fourth position is available on the new mode switch, s.s.b., for product detector reception of s.s.b. or c.w. In the s.s.b. mode the r.f. gain control may be set at maximum to give c.w. and s.s.b. reception with a.v.c. Reducing the r.f. gain and increasing the audio gain gives product detection without a.v.c.

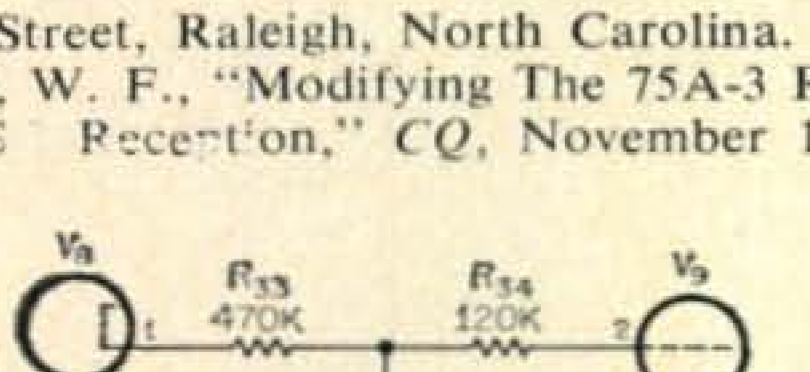

Fig. 1—Circuit of the product detector added to the 75A3 receiver. The values of C_1, C_2, and C_3 are discussed in the text.

This article is not intended to give specific mechanical details. The new product detector tube and the relay can be mounted on a bracket below the chassis in the area under the n.b.f.m. socket. The relay had to be employed because of a not-so-obvious reason. The panel space for the mode switch allows room for only a single wafer switch. The new 4 position mode switch really requires a 4 pole unit. However, the catalogs do not list such a switch on a single wafer, therefore, a 3 pole 4 position switch, single wafer, was employed in conjunction with the relay.

Circuit Description

The circuit of the product detector is shown in fig. 1. It is a modification of a circuit given in the 1965 *ARRL Radio Amateurs Handbook*, page 90. The two unmarked capacitors in series with the i.f. input signal are approximately 2 mmf each and are selected to produce the indicated 0.4 v.r.m.s. for a strong carrier coming out of the i.f. system. The unmarked capacitor in series with the b.f.o. input signal is approximately 20 mmf and is selected to produce the indicated 5.5 v.r.m.s. of b.f.o. signal. These capacitors prevent loading of the b.f.o. and i.f. circuits while controlling the injection levels to the product detector. The detected audio output is 0.25 v.r.m.s. as indicated. With these signal levels, determined experimentally, good audio quality is obtained. Stronger i.f. input signals will yield more audio output, but with more distortion. When b.f.o. injection is removed the audio level of an s.s.b. signal drops over 20 db indicating that the detector output is truly a product of the input.

The modification shown in fig. 2 (identical to the referenced *CQ* article) is employed to give a fast attack a.v.c. characteristic.

Figure 3 shows all the other associated circuits necessary for the proper overall receiver operation in each mode. The poles of the new mode switch are denoted by S_1, S_2 and S_3, all on one wafer. The circuitry of the c.w. limiter, V_{16}, is unchanged except that the plate, pin 2, is now returned to ground through contacts of K_1. Relay K_1, in turn, is controlled by current

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*22 Rowan Street, Raleigh, North Carolina.

[1] Mathemeier, W. F., "Modifying The 75A-3 Receiver for Improved SS Reception," *CQ*, November 1960, p. 82.

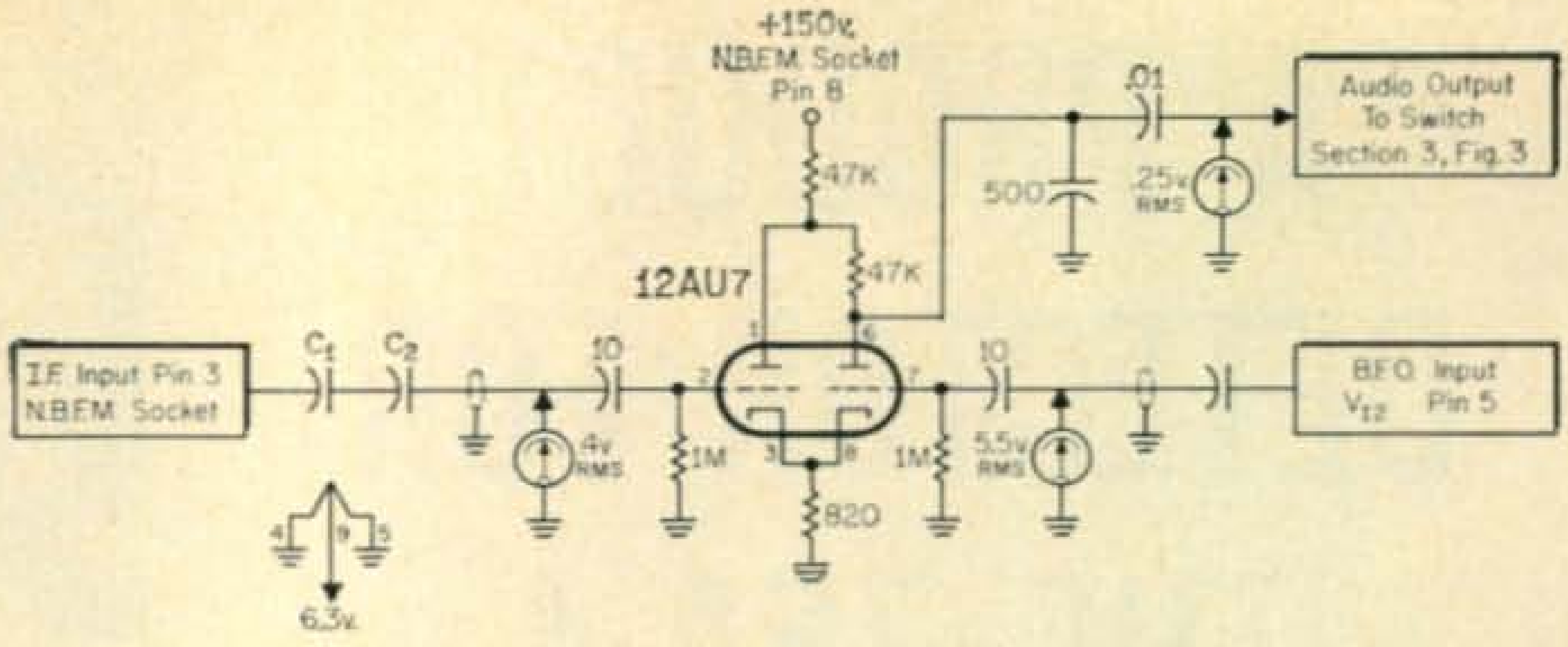


Fig. 2—Circuit of the simple modification necessary to provide fast attack a.v.c. characteristics. A .01 should be soldered from pin 1 of the 12AU7 to ground.

flowing from B+ through its coil to ground through contacts of S_2 in the C.W. position. The relay is a Sigma Plate Circuit type with an 8000 ohm coil. It operates well with 18 volts across the coil. When in the C.W. position current flows through R_1, $R.F.C._1$, diodes CR_1, CR_2 and $R.F.C._2$ to ground. This turns on (low a.c. impedance) the diodes and b.f.o. signal from the oscillator, V_{12}, pin 5, is coupled through C_1, C_2, CR_1 to the diode detector, V_8, pin 2. The exact value of C_2 should be selected to give the 5.5 v.r.m.s. indicated. In all other modes the b.f.o. is isolated from the diode detector. A voltage at the junction of R_3 and R_4 is more positive than the voltage at the junction of R_1 and R_2. This places a blocking (reverse bias) voltage on CR_1 and CR_2. They are held non-conducting and no b.f.o. signal will be fed to the diode detectors. The r.f. chokes are 1 mh each but the value is not critical. (National R40-1 types were used.)

In the A.M. and F.M. modes S_2 turns off the b.f.o. by grounding its screen voltage as in the original Collins design. In the SSB position the b.f.o. is allowed to run and C_3 across the a.v.c. bus provides slow release action.

Switch section S_1 selects either manual or diode derived a.v.c. source and feeds it to the a.v.c. bus.

Section S_3 selects the audio from the proper detector, diode, discriminator, or product, and feeds it to the audio system of the receiver. ■

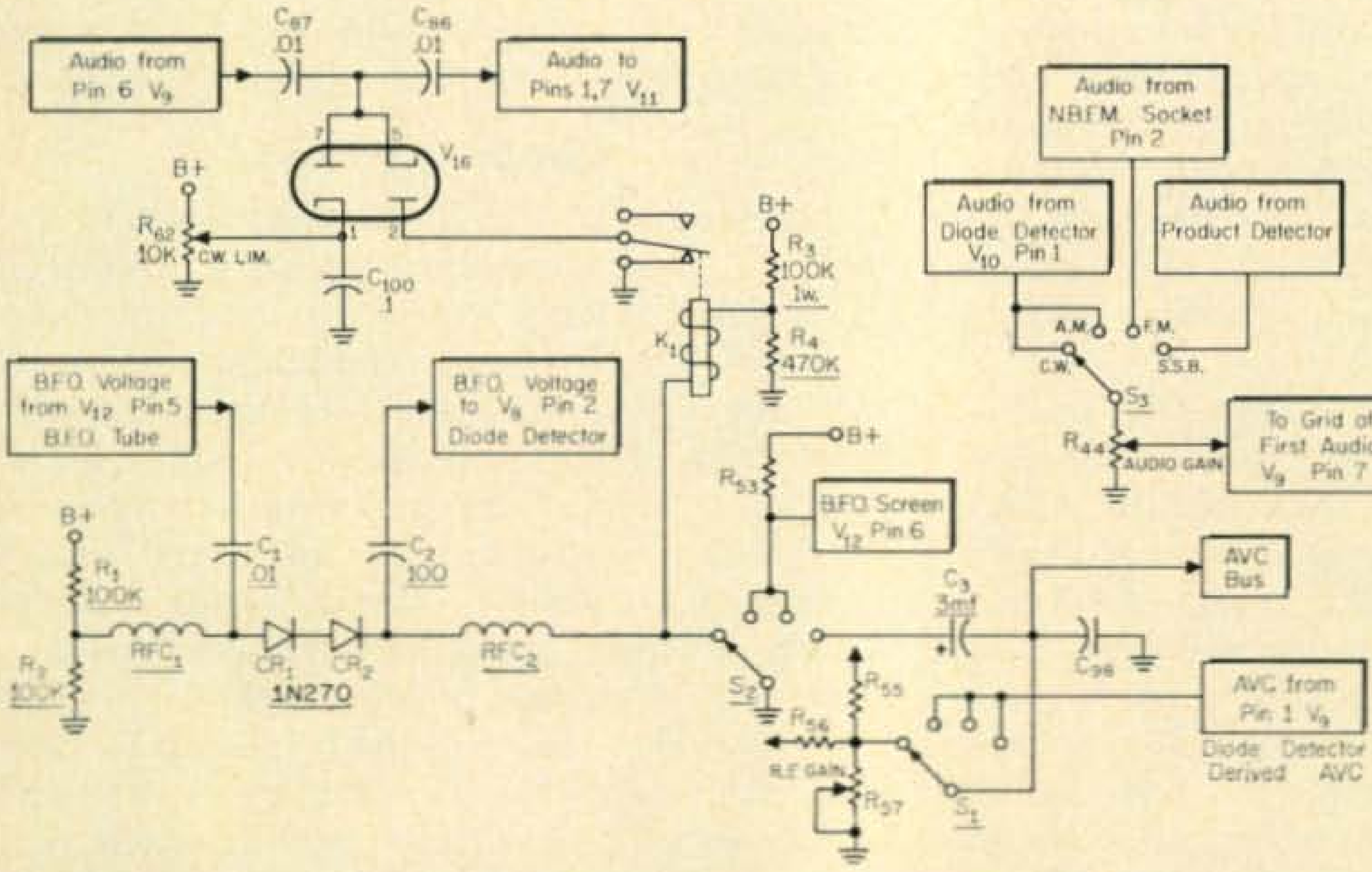
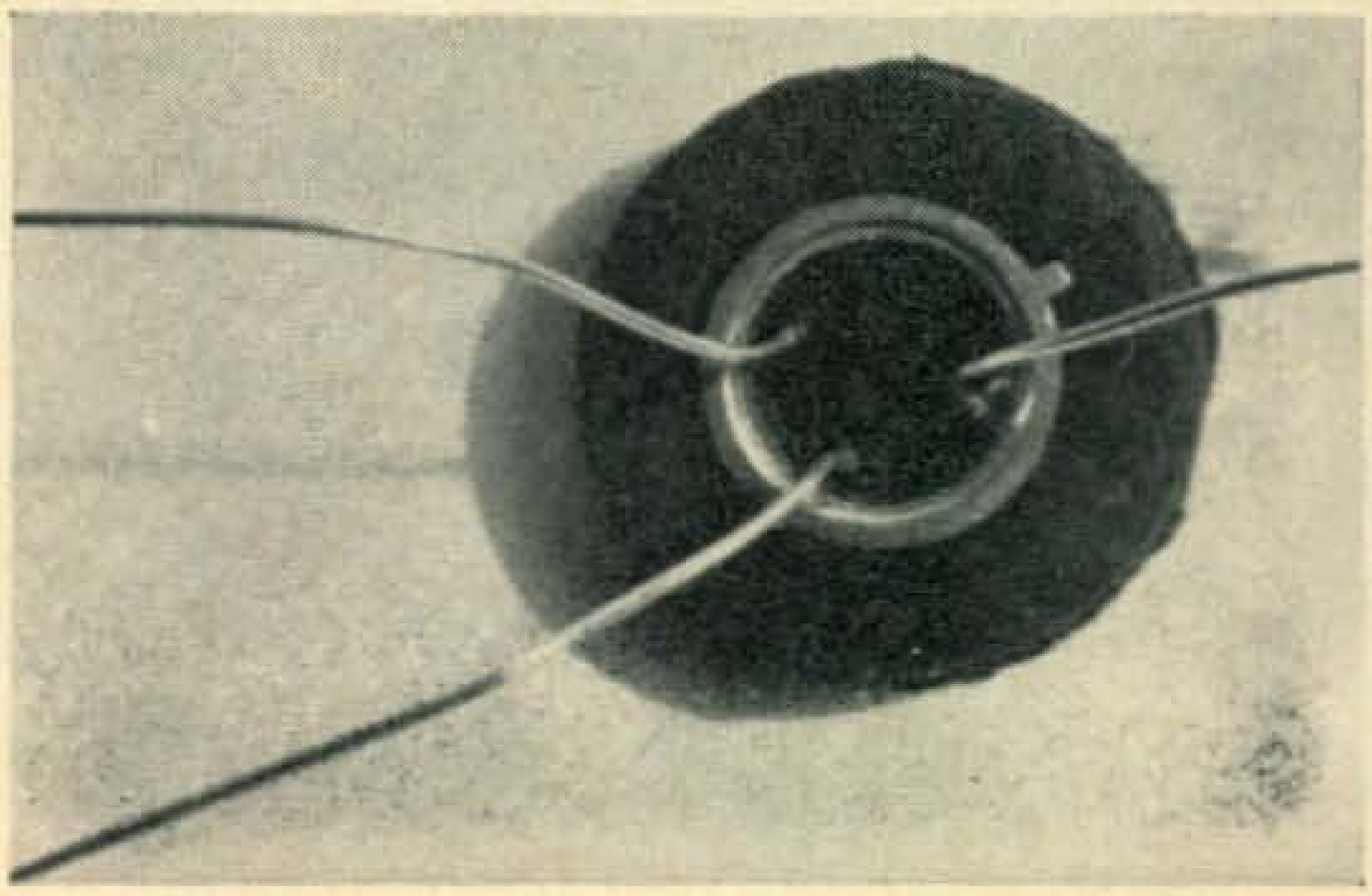


Fig. 3—Circuit showing all the associated wiring and changes necessary to add the new mode switch and product detector to the 75A-3 receiver. The points marked B+ are connected to a 200 volt source and all underlined components are those that must be added. All resistors are ½ watt except where noted otherwise.

GROMMET MOUNTED TRANSISTOR

BY EDWARD A. MORRIS,*
WA2VLU

HERE'S a rugged method of mounting transistors which are to be wired into the circuit. Drill a hole for, and mount a grommet whose inside diameter will provide a snug fit for the transistor. Push the transistor in and wire it up. This will provide the needed support as well as dressing up those projects. ■



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Single Band, Single Operator All-Time African Records

1.8	No Entrant				
3.8	No Entrant				
7.0	No Entrant				
14.0	5A1TW ('64)	291,870	723	35	106
21.0	VQ4RF ('60)	214,389	608	33	90
28.0	VQ4RF ('56)	154,453	520	27	82

Single Band, Single Operator All-Time European Records

1.8	GW3PMR ('65)	360	70	1	5
3.8	ON4UN ('65)	56,700	637	15	55
7.0	I1AIM ('65)	26,465	266	20	59
14.0	F7BL ('65)	703,056	1637	38	115
21.0	DL6EN ('65)	219,090	680	29	80
28.0	DL4AAP ('57)	248,745	745	31	84

Single Band, Single Operator All-Time South American Records

1.8	No Entrant				
3.8	YV5BTS ('65)	14,784	158	10	23
7.0	PY4ND ('64)	2,996	41	13	15
14.0	YV5BIG ('65)	532,352	1417	30	98
21.0	CE3DY ('59)	200,508	531	35	97
28.0	LU1DAB ('60)	126,808	495	26	62

Multi-Operator/Single Transmitter

AF	ET3USA ('65)	1,222,843	1504	77	206
AS	4X4HW ('65)	1,000,050	1159	83	212
EU	I0FGM ('65)	1,129,323	1788	79	220
NA	TI0RC ('64)	740,526	1354	81	168
SA	YV9AA ('64)	1,382,036	1645	84	205
OC	KH6EPW ('63)	423,468	887	69	93

Single Operator, All Band

AF	5A1TW ('63)	662,546	891	68	189
AS	4X4GB ('59)	829,864	977	84	209
EU	DJ6QT ('65)	934,677	1028	99	270
NA	WA2SFP ('65)	652,176	681	94	242
SA	CX2CO ('65)	1,815,288	1849	106	238
OC	ZL1ACI ('65)	577,590	951	70	141

Multi-Operator, Multi-Transmitter

AF	ZD8AR ('65)	2,839,005	2873	103	242
AS	KA2MA ('57)	359,040	711	66	104
EU	OH5SM ('64)	944,790	1553	93	237
NA	XE2BC ('65)	2,091,764	3491	94	187
SA	YV9AA ('65)	4,795,200	3720	112	332
OC	KX6AF ('58)	306,642	771	59	88

Single Band, Single Operator World Records

1.8	GW3PMR ('65)	360	70	1	5
3.8	ON4UN ('65)	56,700	637	15	55
7.0	OX3JV ('65)	37,332	194	25	45
14.0	F7BL ('65)	703,056	1637	38	115
21.0	DL6EN ('65)	219,090	680	29	80
28.0	DL4AAP ('57)	248,745	745	31	84

Single Band, Single Operator All-Time Asian Records

1.8	No Entrant				
3.8	4X4AS ('64)	29,392	227	11	33
7.0	JA2BTV ('65)	23,490	142	23	35
14.0	HL9KH ('63)	318,960	826	37	107
21.0	OD5EG ('62)	169,936	672	24	61
28.0	JA3EK ('59)	87,220	343	33	57

Single Band, Single Operator All-Time North American Records

1.8	No Entrant				
3.8	W1BU ('64)	21,390	129	20	42
7.0	OX3JV ('65)	37,332	194	25	45
14.0	VP7NS ('65)	326,821	1199	28	93
21.0	CO2ZS ('58)	137,013	621	28	81
28.0	W1ONK ('57)	68,448	260	29	64

Single Band, Single Operator All-Time Oceanian Records

1.8	No Entrant				
3.8	No Entrant				
7.0	ZL4BO ('65)	11,232	106	17	22
14.0	KX6BQ ('65)	449,306	1125	36	107
21.0	KH6DLD ('59)	92,870	453	28	46
28.0	ZL1KW ('58)	63,729	299	28	45

STATION	BAND	QSO'S	ZONES	COUNTRIES
YV9AA (1965) 4,795,200	1.8	2	1	1
	3.8	151	13	33
	7.0	351	19	57
	14.0	1651	32	110
	21.0	958	24	75
	28.0	607	23	56
	TOTAL	3720	112	332

STATION	BAND	QSO'S	ZONES	COUNTRIES
YV9AA (1964) 1,382,036	1.8	1	1	1
	3.8	88	12	23
	7.0	165	14	35
	14.0	871	31	89
	21.0	473	19	46
	28.0	47	10	11
	TOTAL	1645	87	205

STATION	BAND	QSO'S	ZONES	COUNTRIES
CX2CO (1965) 1,815,288	1.8	—	—	—
	3.8	26	12	17
	7.0	73	16	24
	14.0	785	33	87
	21.0	594	25	61
	28.0	371	20	49
	TOTAL	1849	106	238

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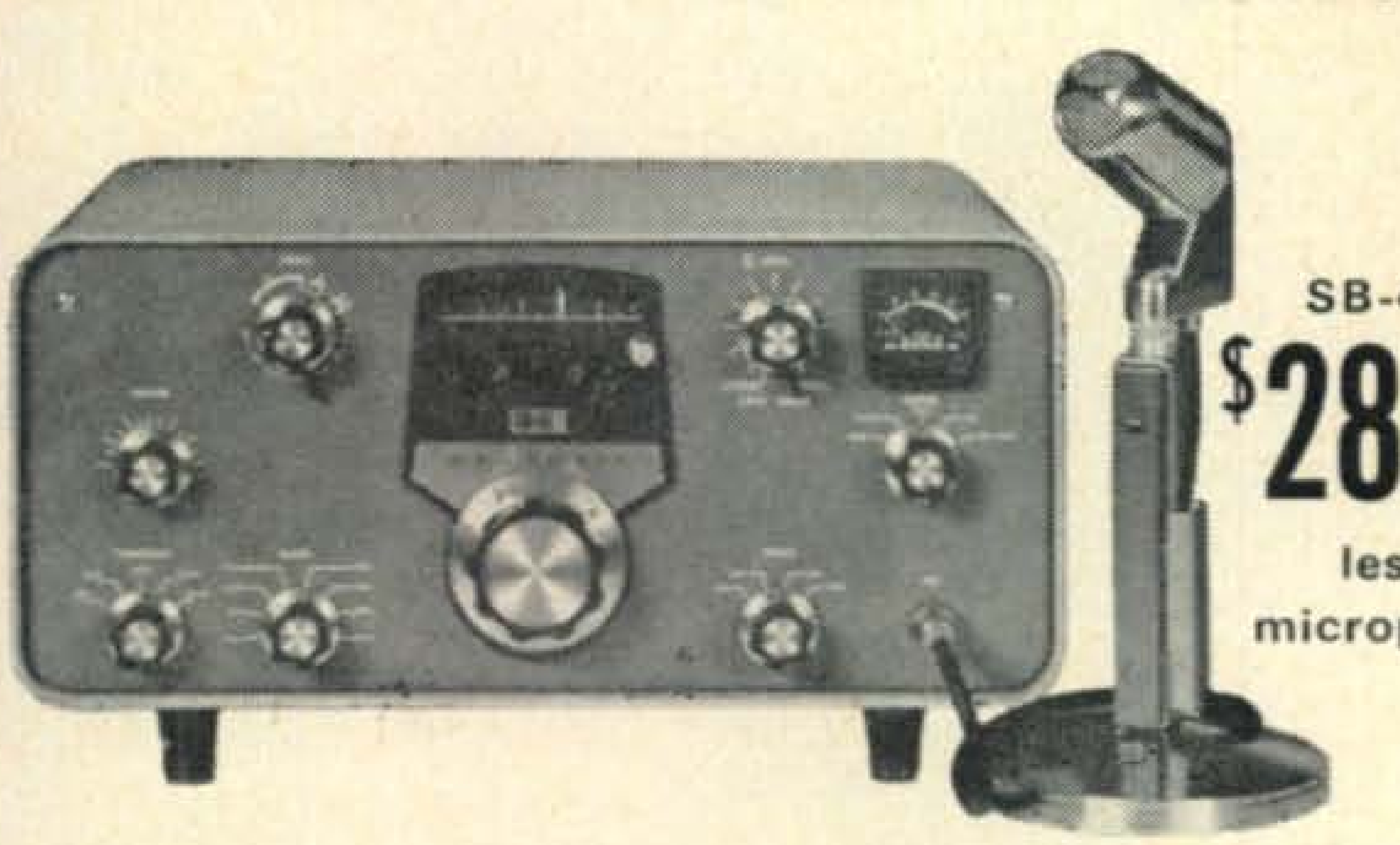

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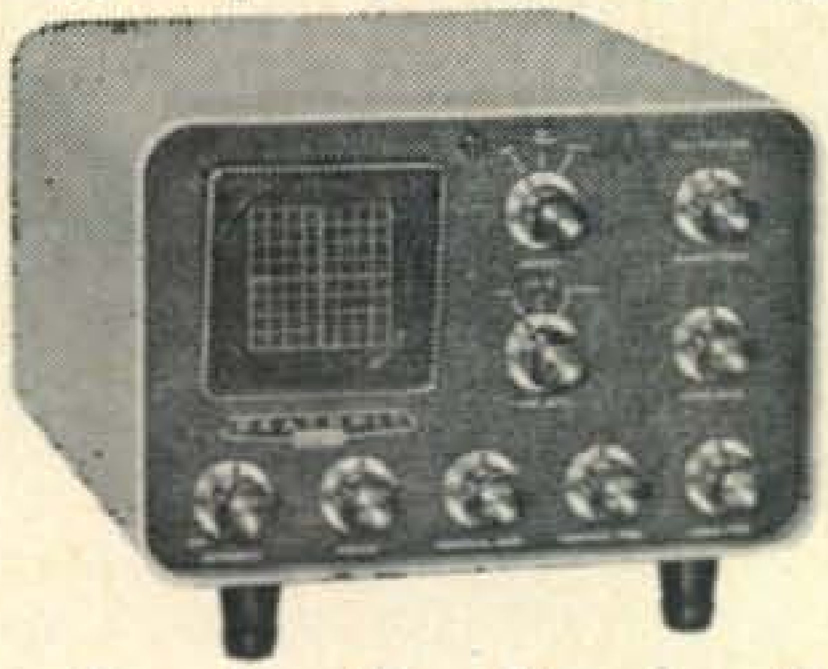

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UNDERSTANDING
Field Effect Transistors

BY HARRY R. HYDER,* K7HQN

Part III

Part III, the concluding installment of the f.e.t. series, covers practical f.e.t. operation and some basic design practices suitable for the amateur.

THE f.e.t. has a remarkable list of virtues and few disadvantages. But it is hardly enough to start you off on the design of a new receiver using f.e.t.'s. An attempt will be made here to outline some of the principles of f.e.t. circuit design.

Practical F.E.T. Operation

The very heart of f.e.t. circuit design is proper biasing, and in general there is only one kind of operation that need concern us: Class A. There are no f.e.t. equivalents to Class B or C vacuum tube operation, where grid current is drawn, since f.e.t.'s do not respond to forward-bias gate voltages in the same way that tubes respond to positive grid voltages.

The designer of commercial and military equipment is faced with the problem of engineering his circuits so that they will furnish uniform performance over a wide range of temperature and other environmental conditions, and so that they will tolerate the very wide initial variation in characteristics present in most semiconductor devices.

He does this by designing for the worst case; that set of electrical and environmental conditions that gives him the worst possible performance. Then he designs features into his circuits that will, in effect, force every more favorable set of conditions down to the worst-case level. He then knows that, come what may, he can guarantee some minimum standard of performance.

The most-used way of equalizing the performance of amplifying devices is by the use of d.c. degeneration. With tubes, this takes the form of a large cathode resistor, and with field effect transistors would take the form of a large resistor in the source circuit. If the resistor is large enough, the current through the device is determined mostly by the resistor and the bias supply, rather than the initial characteristics of the f.e.t. or the temperature.

Biasing

For any specific type of f.e.t., transconductance is roughly proportional to I_{DSS}, the channel current with the gate connected to source. This may have an initial manufacturing variation of three to one or greater. Constant-current biasing will make all f.e.t.'s of one type look like that particular one having the lowest transconductance. Various forms of constant-current biasing are shown in fig. 9. Of course, the source terminal should be bypassed to ground.

This is fine engineering practice, but I wouldn't recommend it for hams. As a rule, the ham is building only one piece of equipment at a time, and interchangeability is no problem. He will do better by making a few simple d.c. measurements and optimizing the bias for each individual f.e.t.

This is easily done; merely measuring I_{DSS} of each unit gives all the information necessary to start. This measurement should be made at the intended supply voltage; the test setup is shown in fig. 10.

Incidentally, if you buy a number of f.e.t.'s for a receiver, pick the one with highest I_{DSS} for the first r.f. amplifier; this one will give the highest gain and lowest noise.

The bias must be chosen so that under any conditions of voltage, current, or temperature, no rating is exceeded. The manufacturer always gives a figure called "Total device dissipation at 25° C," together with a derating factor or curve for higher temperatures. Applying the proper derating and dividing the result by your intended drain-to-source voltage will tell you the maxi-

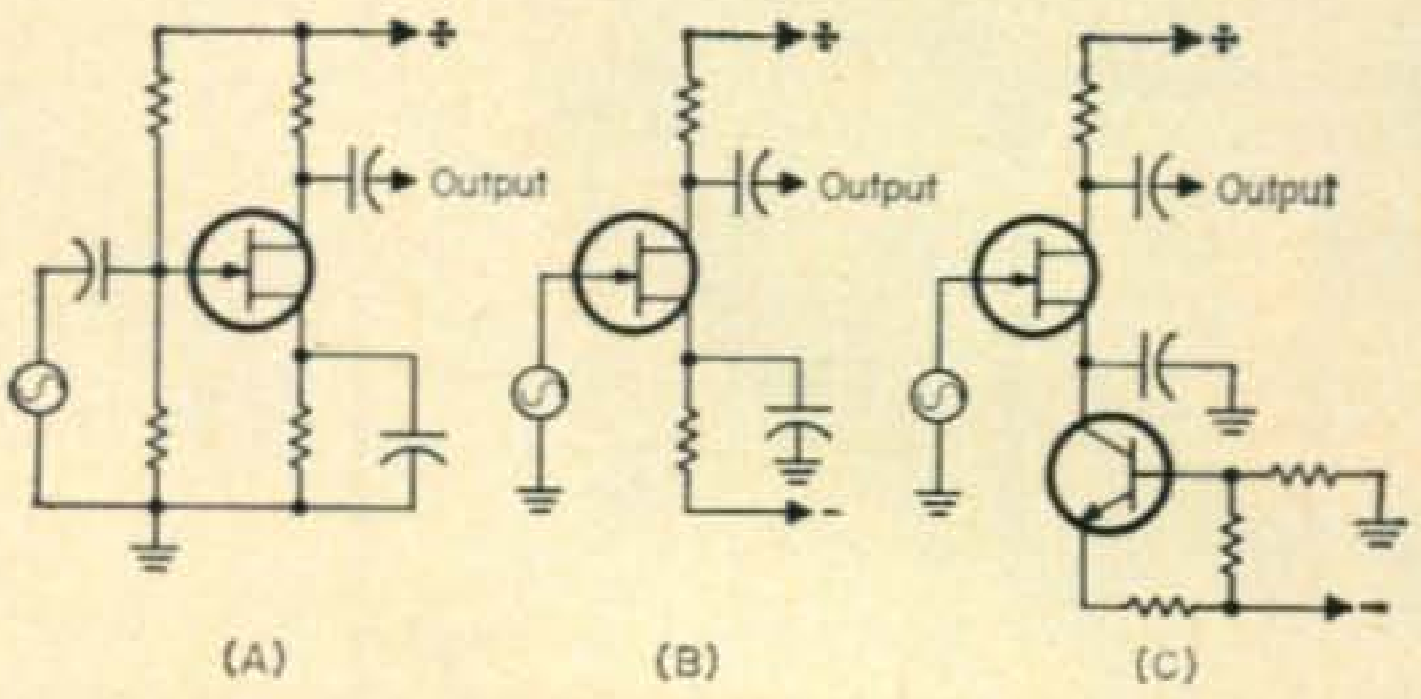

Fig. 9—Three circuits to provide constant current biasing for f.e.t.'s.

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*Senior Engineer, Motorola Inc., Military Electronics Division, 8201 E. McDowell Road, Scottsdale, Arizona 85252.

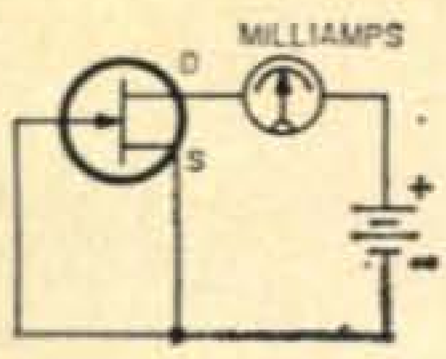


Fig. 10—Test set-up for measuring I_{DSS} of an f.e.t.

mum channel current you can run. As an example, the 3N126 tetrode has a 25° C. dissipation rating of 300 mw, with a derating factor of 1.71 mw per degree C for higher temperatures. If we derate to a 75° C. ambient, which would be an extremely high temperature in amateur service, we would have a maximum permissible dissipation of $300 - (1.71)(50) = 214$ mw. Therefore, the maximum permissible channel current at, say, 12 volts drain-to-source would be $0.214/12 =$ 18 ma. The specifications for the 3N126 also say that the maximum I_{DSS} is 9 ma, so we are faced with the happy fact that we would be safe with no external bias at all, particularly since I_{DSS} decreases with temperature.

Unfortunately, the reverse is also true: I_{DSS} increases as the temperature drops. There is no way of calculating the temperature coefficient of I_{DSS} from the information usually given on the data sheet, but if you assume a 25% increase you will be pretty safe. This, of course, is about a 50% increase over the room temperature dissipation.

Operation with no external bias is perfectly permissible under some conditions; the f.e.t. has some built-in bias, as explained earlier. But it should be first ascertained that no rating will be exceeded. And also, this should be restricted to small-signal operation, and circuits where there is very little resistance in the d.c. circuit. Both of these conditions are usually met in a receiver r.f. or first i.f. amplifier. Zero-bias operation should not be attempted where the input signal is likely to exceed a tenth of a volt, or where the average plus peak drain current exceeds I_{DSS} appreciably.

It is desirable to use some external source resistance. Much is gained from the standpoints of safety and gain stability. For an r.f. or i.f. amplifier, I would recommend biasing f.e.t.'s to about one-half of I_{DSS}. Not too much gain is lost; at half of I_{DSS}, the G_m has decreased only about 30% from its maximum value.

A simple and very practical way of biasing f.e.t.'s to this point is to select the proper value of bias resistor for each f.e.t. This is easily done with nothing more than a power supply, a milliammeter, and a handful of resistors.

If you prefer to be a little more analytical, you can determine graphically a value of self-bias resistor that will be reasonably satisfactory for all your f.e.t.'s of one type. However, you will need to measure not only I_{DSS}, but also the transconductance at I_{DSS}. You can do this easily and fairly accurately with the test setup in fig. 11. While the transconductance is defined as the ratio of the change of drain current to the change of gate voltage for infinitesimally small changes, merely measuring the gate voltage required to reduce the drain current of 90% of I_{DSS} will introduce little error. Then,

$$G_M\,(\text{at } I_{DSS}) = \frac{\Delta I_D}{\Delta V_{GS}}$$

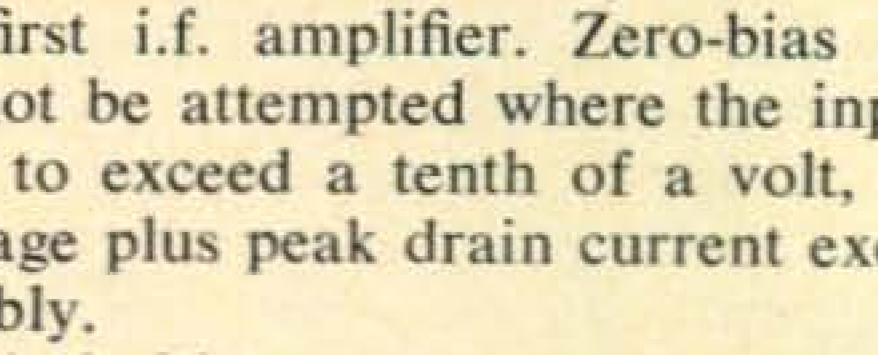


Fig. 11—Test set-up for measuring the G_M of an f.e.t. at I_{DSS}.

You now have everything you need to plot the characteristics of all your f.e.t.'s, using the equations

$$V_P = \frac{2\,I_{DSS}}{G_M}$$

and

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

which were introduced earlier. The result for three f.e.t.'s would look something like fig. 12.

From these curves you can determine the effect that any single value of self-bias resistor will have on the drain current of all f.e.t.'s plotted. For example, if we decided that it would be desirable to bias the "average" f.e.t. at 2.3 ma, we would draw a straight line through this point to the intersection of the ordinate and abscissa. The slope of this line is the required self-bias resistance, in this case about 680 ohms. The drain current, and equivalent gate voltage, for any of the f.e.t.'s can now be picked off the appropriate curve.

It is apparent that the variation in drain current between units will be substantial. In the example shown, which is by no means extreme, the quiescent drain current variation between units will be almost two to one. Temperature, which has not been considered because of the difficulty of determining its effects from the data sheet, will make the variation greater. So will the tolerance on the self-bias resistor. It is an excellent idea to be very conservative.

This variation can be greatly reduced by increasing the value of the self-bias resistor. This brings it a little closer to the constant-current case. What would be the variation with, say, a 2.2K ohm self-bias resistor? This has been plotted on the graph, intersecting the #2 f.e.t. curve at the same point as the 680 ohm resistor. The variation of quiescent drain current is now only about 25%, a substantial improvement.

We seem to have produced an anomaly: the gate voltage required to bias f.e.t. #2 to 2.3 ma is 1.55 volts, but 2.3 ma flowing through 2.2K ohms produces 5 volts. What do we do?

The answer is on the graph. Since the 2.2K ohm line intersects the abscissa at +3.45 volts (the difference between 5 and 1.55 volts), we must provide 3.45 volts of positive gate bias to overcome the excess bias caused by the 2.2K ohm resistor. This can be obtained easily by a voltage

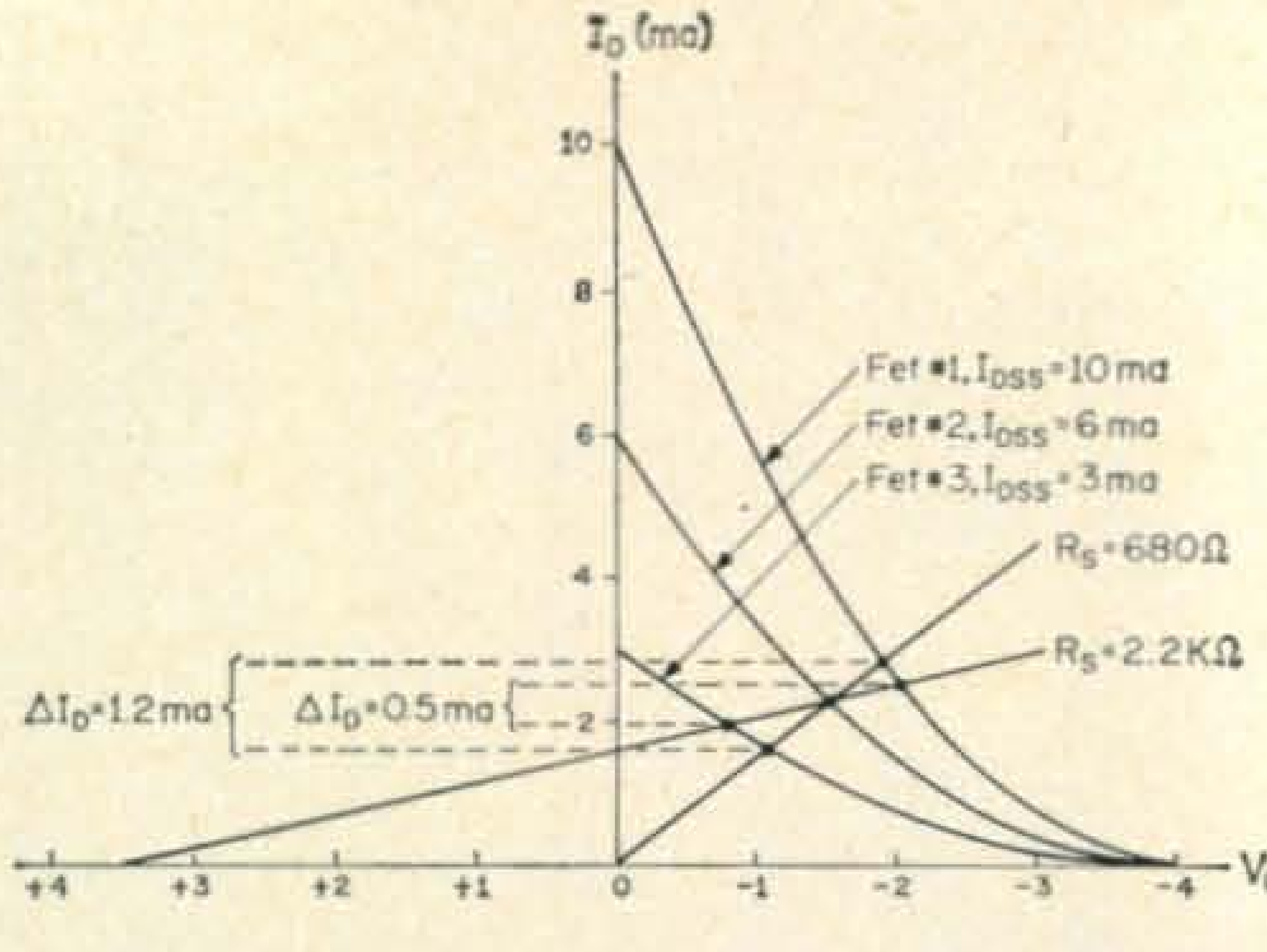


Fig. 12—A graphical method for determining the value of the self-biasing resistor described in the text.

divider from the supply voltage, as was shown in fig. 9(A).

These curves show graphically the virtues of selected bias resistors when maximum gain per f.e.t. is desired and interchangability is not a factor.

R-C Coupled Amplifiers

The biasing procedure just outlined is applicable mostly to amplifiers and oscillators that have load circuits of low d.c. resistance, such as r.f. or i.f. amplifiers, where the drain-source voltage is not affected by the drain current.

Resistance-coupled amplifiers require a slightly different procedure. Similar to vacuum tubes and transistors, the idea is to bias the f.e.t. to make the quiescent d.c. drain voltage about half of the supply voltage.

This can be done experimentally, or graphically using a variation of the procedure just described. First select your load resistor, then calculate the current necessary to produce a drop across this resistor of half the supply voltage. Plot this point on the f.e.t. curves; you will have to expand the curves in the low-current region to do this accurately. The slope of the line drawn through this point to zero is the required self-bias resistor. Use the closest higher standard value of resistor.

Oscillators

Oscillators are biased in the same way as amplifiers. Amplitude can be controlled by varying the source resistor. There should always be some resistance in the gate return circuit, since high feedback could cause sufficient gate current to damage the gate.

Biasing Mixers

As explained earlier, optimum bias for a f.e.t. mixer or heterodyne detector is one-half of the pinch-off voltage. When so biased, the drain current will be 25% of I_{DSS}. This, of course is with no signal or oscillator injection voltages present. The bias is not critical. The proper value of source self-bias resistor is best arrived at experimentally. When used as the second detector in a superheterodyne, the resistor should be by-passed for audio, to prevent degeneration.

Surface Field Effect Transistors

Surface f.e.t.'s, as the name implies, work by virtue of effects taking place near the surface of the semiconductor, rather than in the bulk material. They are called variously "Isolated Gate F.E.T.'s", "Metal-Oxide-Silicon F.E.T.'s", "MOSFET's", and numerous other names, depending on the whims of their manufacturer's advertising departments.

When the gate of a junction f.e.t. becomes forward-biased, the input impedance falls to a very low value, and the drain current no longer bears a useful relationship to the input signal. The device essentially ceases to be a f.e.t.

The question might be asked, "Since the gate normally draws no current, what would be the effect of placing an insulator between gate and channel?" The answer is that, in principal, nothing would happen; the electrostatic field of the gate would continue to deplete the channel as it did before. However, there is no longer any point in using a semiconductor for the gate; an ordinary metal will do as well. In practical surface f.e.t.'s, the insulator is a thin layer of oxide formed thermally on the semiconductor surface, and the gate is a layer of metal, such as aluminum, evaporated on the oxide.

Such a device, shown in fig. 13(A), would be called a "Depletion Mode Isolated-Gate F.E.T.", and it would have characteristics similar to those of a junction f.e.t., except that the gate leakage current would be far lower.

The next question asked might be, "What happens when the gate of such a device is forward biased?" Well, if the unit is designed properly, the forward bias can actually enhance the con-

Fig. 13 (A)—Construction of an isolated gate f.e.t. depletion mode only. (B)—Construction of an isolated gate f.e.t. capable of operating in the enhancement *and* depletion modes. (C)—Construction of an f.e.t. capable of operating in the enhancement mode only (shown not enhanced). (D)—The f.e.t. of type (C), an enhancement mode only type, shown enhanced.

ductivity of the channel, cause it to draw more current.

Figure 13(B) shows an f.e.t. capable of operating in both the enhancement and depletion modes. The channel is a lightly-doped N semiconductor of moderate conductivity. The source and drain areas are heavily-doped "N+" regions. A negative gate voltage will deplete the channel. A positive gate voltage will "induce" charges into the channel, increasing its conductivity. The surface of the channel, the oxide insulator, and the gate, form a capacitor. A positive voltage on the gate must cause an equivalent negative charge on the channel surface under the dielectric. The negative charge is actually a concentration of electrons.

A third type of surface f.e.t. operates in the enhancement mode only. In the absence of a forward gate voltage, no channel current at all flows. A unit of this type is shown in fig. 13(C). The channel is a P material, with source and drain of N+. The channel is thus an n.p.n. junction, and with the gate open, no channel current can flow regardless of the polarity of the battery, because one of the two channel junctions is always reverse biased. If a sufficiently high forward bias is applied to the gate, enough negative charges are induced into the channel to bridge the gap between source and drain, causing the channel to become conductive. The P channel has actually had its surface converted into an N semiconductor.

The transfer characteristics of surface f.e.t.'s follow the same laws as those of junction f.e.t.'s. Figure 14 shows the relative characteristics. Note that in the enhancement-mode only f.e.t., I_{DSS} is zero.

It is difficult to predict at this time whether surface f.e.t.'s will supplant junction f.e.t.'s. An enormous amount of commercial activity is going on in all types. For the present, however, junction f.e.t.'s are cheaper, and this is an important factor to amateurs. Only time will tell.

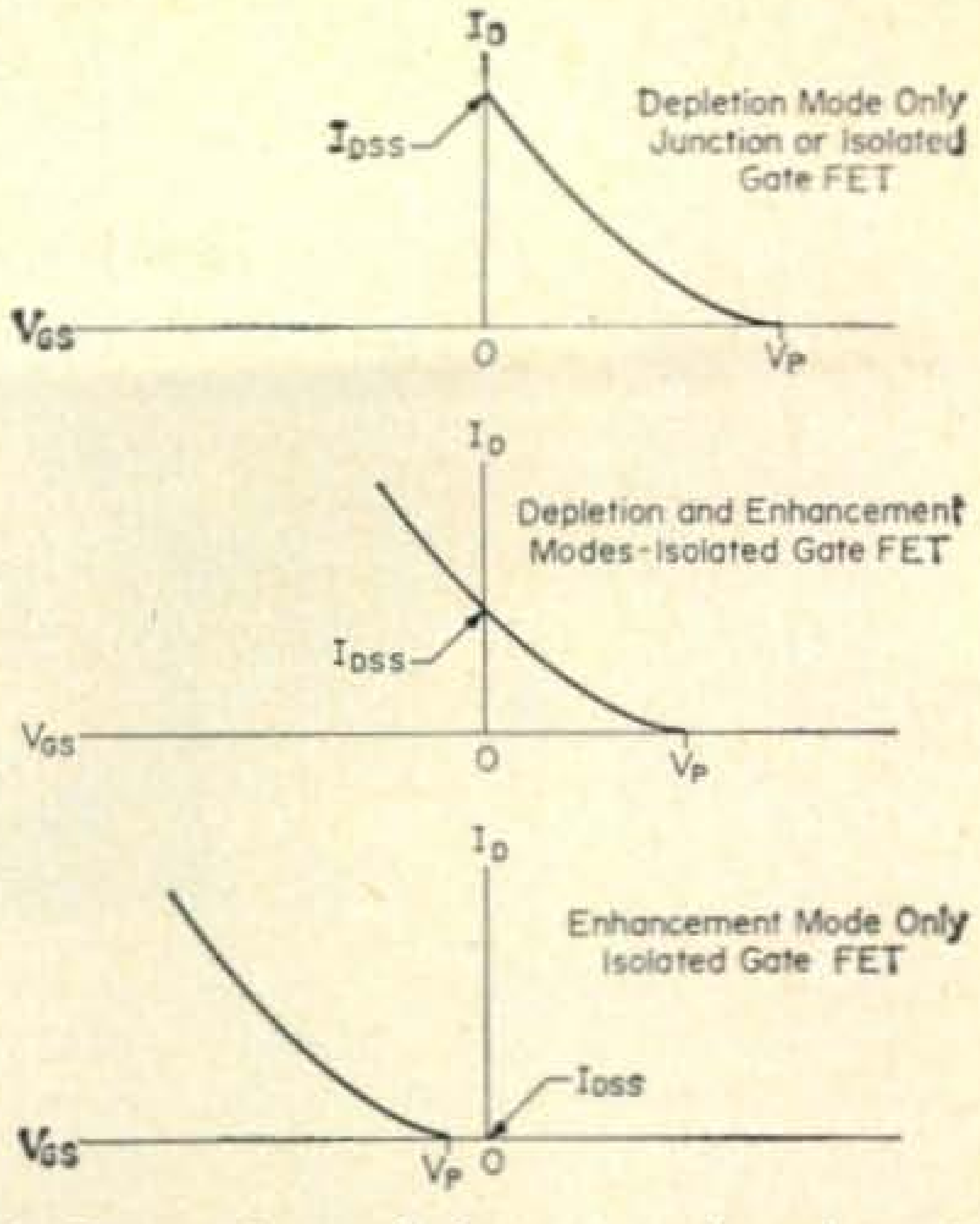


Fig. 14—Comparison of f.e.t. transfer characteristics.

Conclusion

Since the introduction of the bipolar transistor, new semi-conductor devices have flowed from the laboratory in profusion. Some have earned permanent places in our catalog of useful electronic devices. Some have never made it. I think the f.e.t. will be one of the more widely-used devices. I don't know whether it will ever completely replace the bipolar transistor, but it will certainly strongly supplement it.

While f.e.t.'s now on the market are low-power units, high-power devices are possible and should not be long in coming. And prices will certainly decrease; even now, some types cost less than $5.00 in unit quantities.

Because of the predictability of its characteristics, and because it is a majority-carrier device, f.e.t. circuit design should be simpler than for bipolar transistors; this should help to popularize them with experimenters.

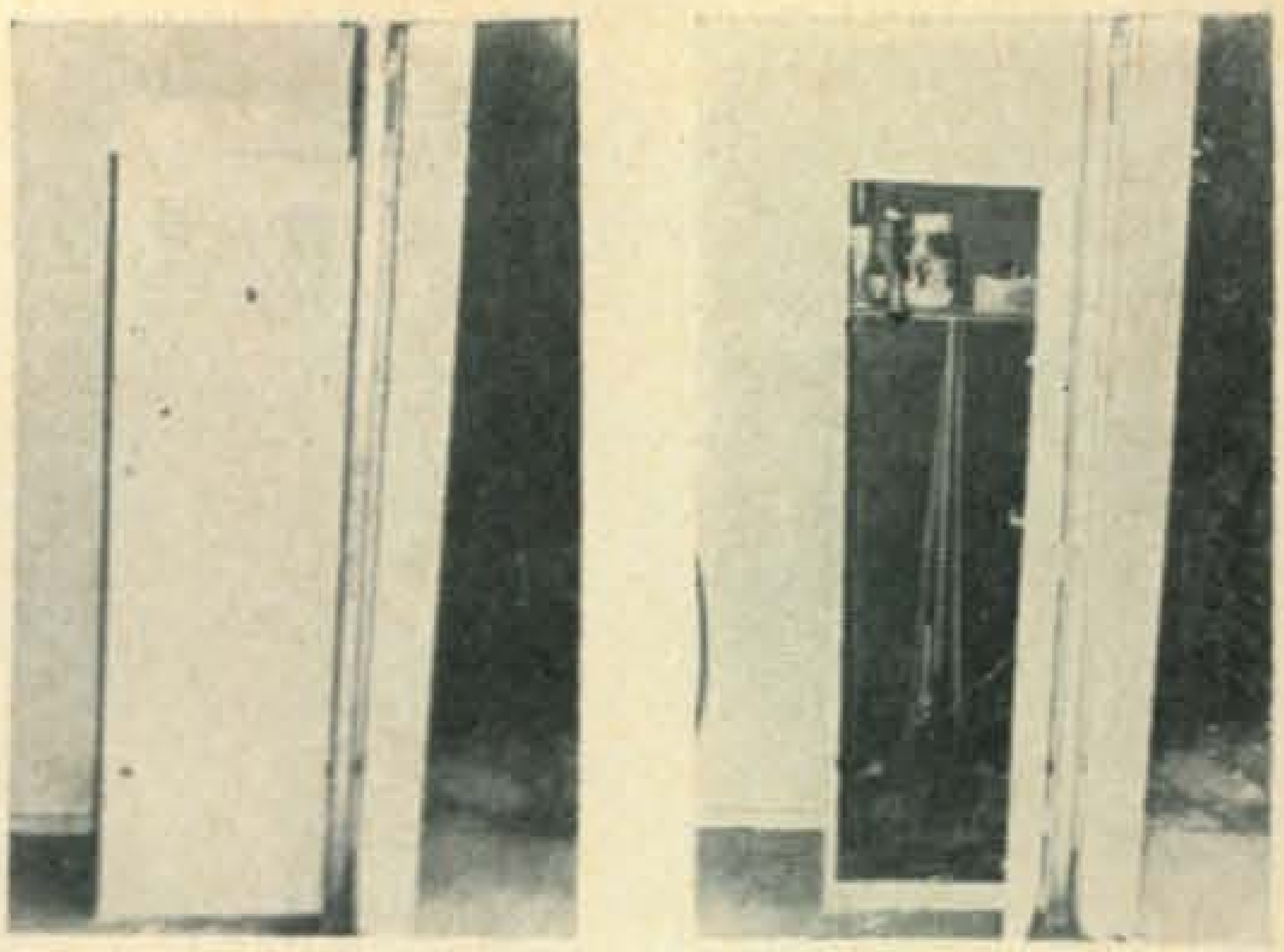
There are very few low-power applications where f.e.t.'s can not be used to advantage. Why not give them a try? ■

New Amateur Product

Electro Products

ELECTRO Products introduces the Model TI-250 a transistorized inverter that delivers 250 watts 60 cycle continuously, and 300 watts intermittently. The unit is 4½" × 10" × 7½", and weighs 9 lbs. Optional equipment includes a remote control console. The inverter includes a built in "start" switch for hard to start loads, a battery low charge warning light and ON-OFF switch. The price for the TI-250 is $89.50. Full data can be had by writing to Electro Products Labs, 6123 W. Howard Street, Chicago, Illinois, 60648, or circling 73 on page 112.

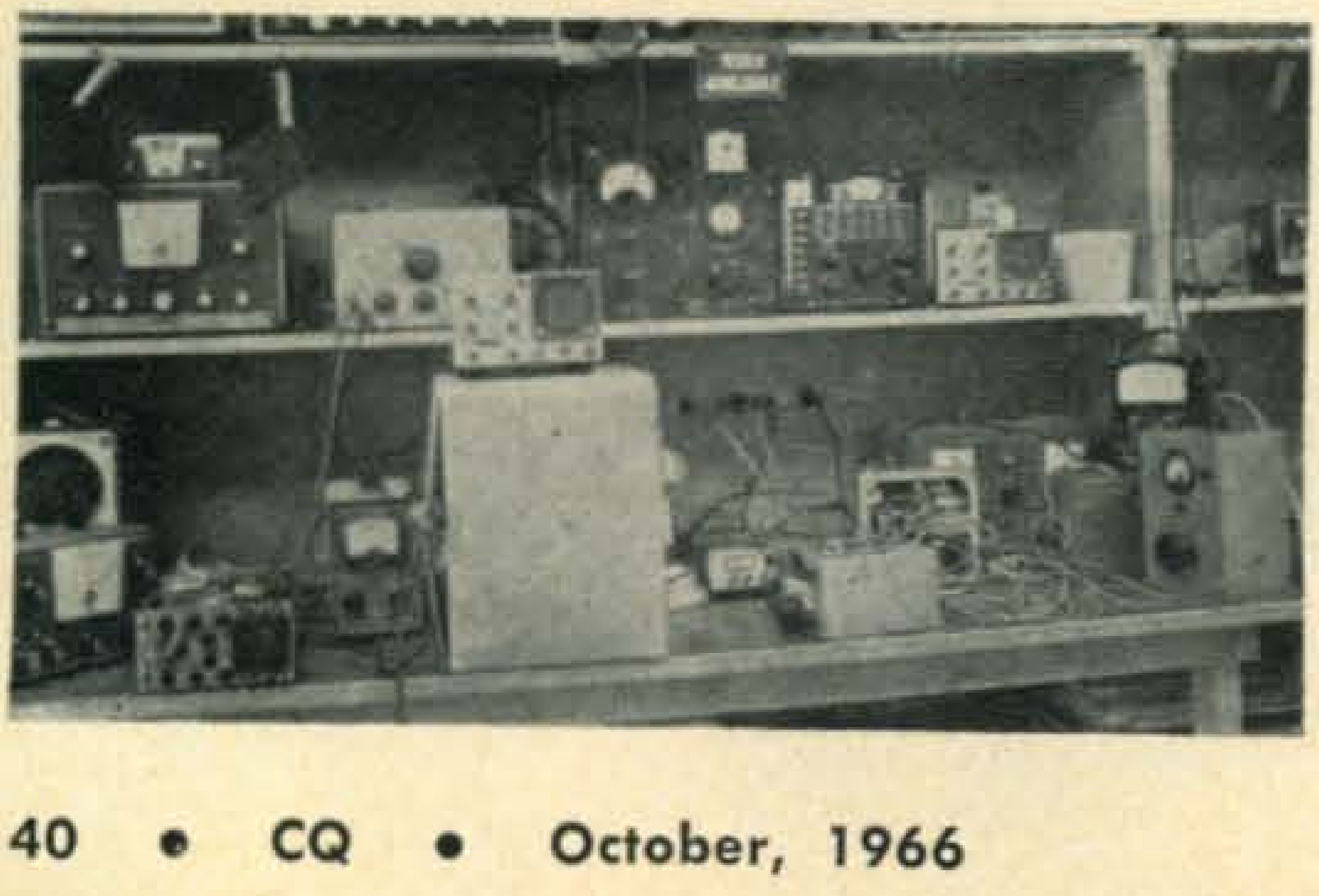
John McFarlin, WA0OEE sent along this photo of his new QTH. John now signs G5ABM/WA0OEE. He received his new license last March when he was stationed in England with the U.S.A.F. John expects to be operating this impressive station until sometime next summer.



These two photos could be titled "They also serve who stand and wait." Actually it's the sad aftermath of another convert to s.s.b. When Harold, W8NFD, abandoned the rack mounted a.m. rig in favor of a table top s.s.b. rig he found a new use for the trusty old rack. Although still standing not quite so gallantly, it still proudly serves.

PEOPLE AND PLACES

This past June over 15,000 Rotarians gathered for the Rotary's 57th International Convention in Denver, Colorado. They came from 63 countries of the world. Within this group were members of ROAR (Rotarians Of Amateur Radio), a group founded six years ago which now has over 500 members in 23 countries. This group is shown registering at the ROAR booth, they are: l. to r. Bill Bennett, W7PHO, Hugh Archer, W8RPX, Irv Geller, WA1CDW, Robert A. Galbasin, W0MHN, Charles S. Sterne, W0UJS, Bill Caldwell, K7KUS, and I. J. Baugher, K4AXH.



This could be Jess, K2EEM, putting the finishing touches on the big rig for 20, but it's not. Jess is shown at his job with AMF completing a 280 kw welder. For those of you who are spec conscious, the welder will permit continuous welding of half inch thick steel pipe up to two feet in diameter at speeds of up to 42 ft. per minute.

← Ever wonder how Bill Scherer gets those great scope photos for the Oscilloscope articles? Its simply the graphic interpretation of the integrated perfusion of equipment on his bench.

A 3-band SSB Transceiver Kit for $189.95

An Electronic Keyer Kit for $49.95

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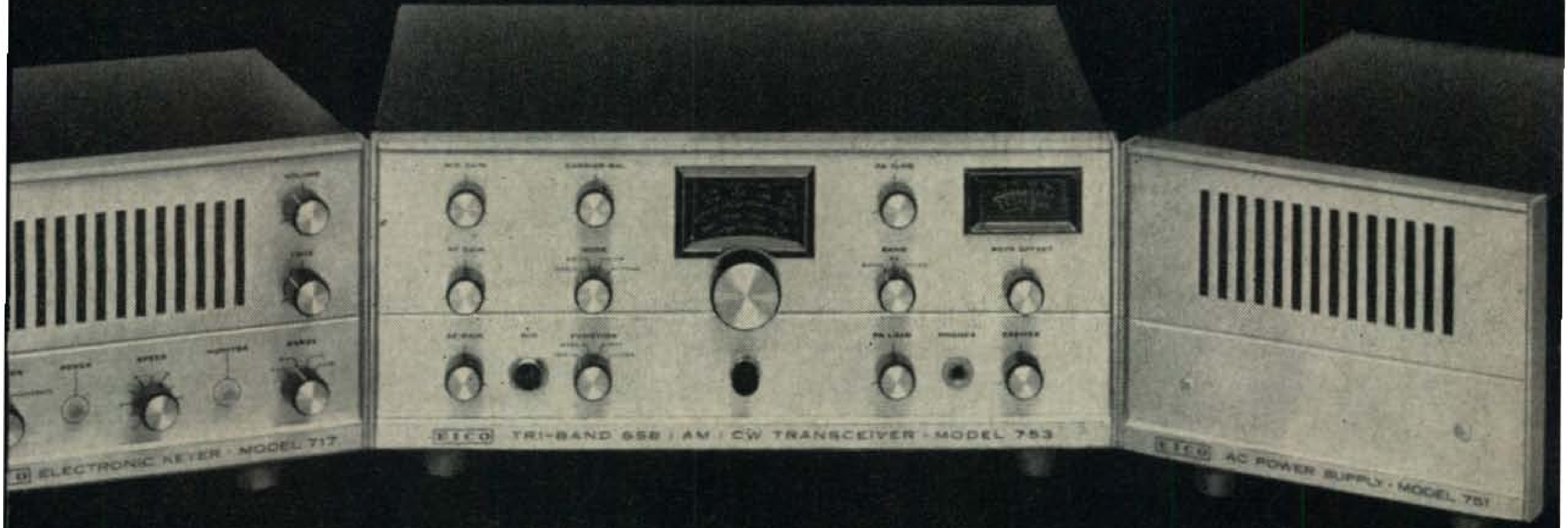

Who else but EICO

Pro **all the way, from concept to execution — that's what ham editors say about EICO. Critical customers agree, and like the low price, too. They've made the 753 kit, for example, the industry's hottest seller. And the new 717 Keyer seems headed for the same fate. Highlights of both give you some inkling why:**

The EICO 753 is a complete 3-band transceiver, offering SSB/AM/CW operation with conservatively rated 200 watts PEP on all modes (rated for maximum efficiency rather than maximum possible input power). A new Silicon Solid State VFO provides full coverage of the 80, 40, and 20 meter bands. Assembly is made faster and easier by VFO and IF circuit boards, plus pre-assembled crystal lattice filter. Rigid construction, compact size, and superb styling make this rig equally suited for mobile and fixed station use. The EICO 753 is at your dealer now, in kit form and factory-wired.

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SPECIFICATIONS: Output Voltages: 750 volts DC at 300ma, 250 volts DC at 170ma — 100 volts DC at 5ma, 12.6 volts AC at 4 amps. INPUT VOLTAGE: 117VAC.

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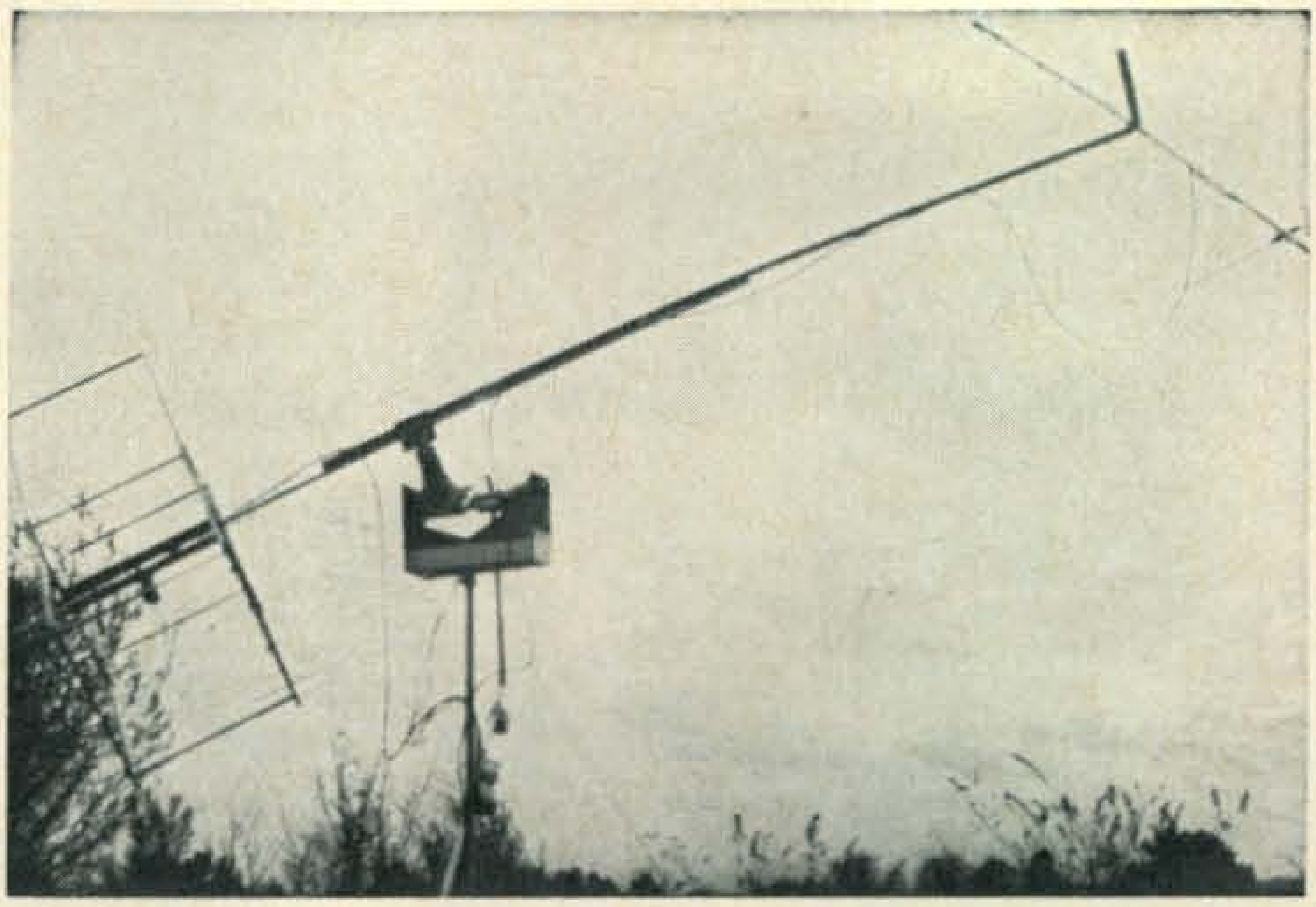

Overall view of the mount shows the 432 mc yagi quad on the left and the 144 mc yagi on the right. The weights can be seen secured to the counterbalance arm.

A SIMPLE ANTENNA MOUNT FOR SATELLITE WORK

BY CARL A. EBHARDT,* W4HJZ

Over the past few years the author has constructed numerous temporary antenna setups for moonbounce via KP4BPZ and for the Oscar series of satellites. All arrays were of the azimuth-elevation type and hand operated. When the time came around for constructing Oscar IV antennas, it was decided that too much time was being wasted on these temporary mounts and a more permanent rotor driven system was in order.

The polar mount is best for tracking the moon because the elevation angle above the southern horizon is constant for a given pass of the moon, and only one direction of rotation is necessary to follow the moon across the sky. The azimuth-elevation mount is more flexible and can aim an array in any direction. Its disadvantage is that two rotor controls must be simultaneously manipulated to follow an object across the sky. The advantages of both mounts can be had in an elevation-azimuth system. With the EL-AZ mount, by aiming the array south and elevating it to the proper angle above the southern horizon, the azimuth rotor becomes the "hour angle" and the elevation rotor need not be touched for an entire pass of the moon, or any other equatorial orbit satellite. By aiming the array east or west and fixing it in place, the elevation rotor aims the array at the desired angle above the eastern or western horizons and the azimuth rotor makes the array follow a polar orbiting satellite.

To set up the array for polar or equatorial orbits, the mast must be rotated 90° and this is done by hand. The U bolts at the base of the mast are loosened, the mast rotated, and then the U bolts tightened.

For elevation and azimuth controls Cornell Dubiliev TR-44 rotors were chosen for their good torque and indicator accuracy. However, these rotators have a brake mechanism that works via gravity on the motor shaft. When employed in a horizontal position the brakes do not operate properly. The rotors must be modified.

[*Continued on page 105*]

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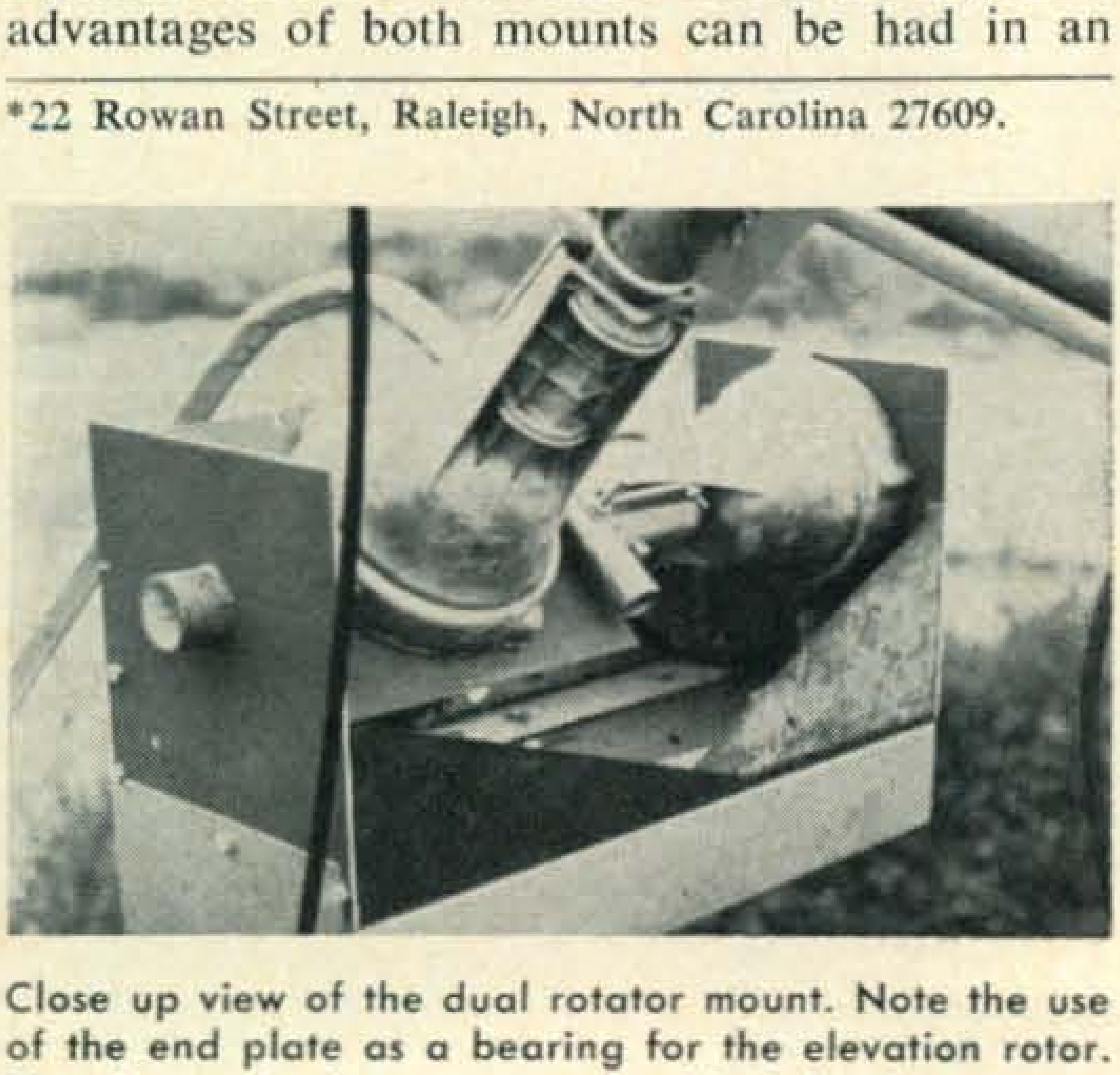
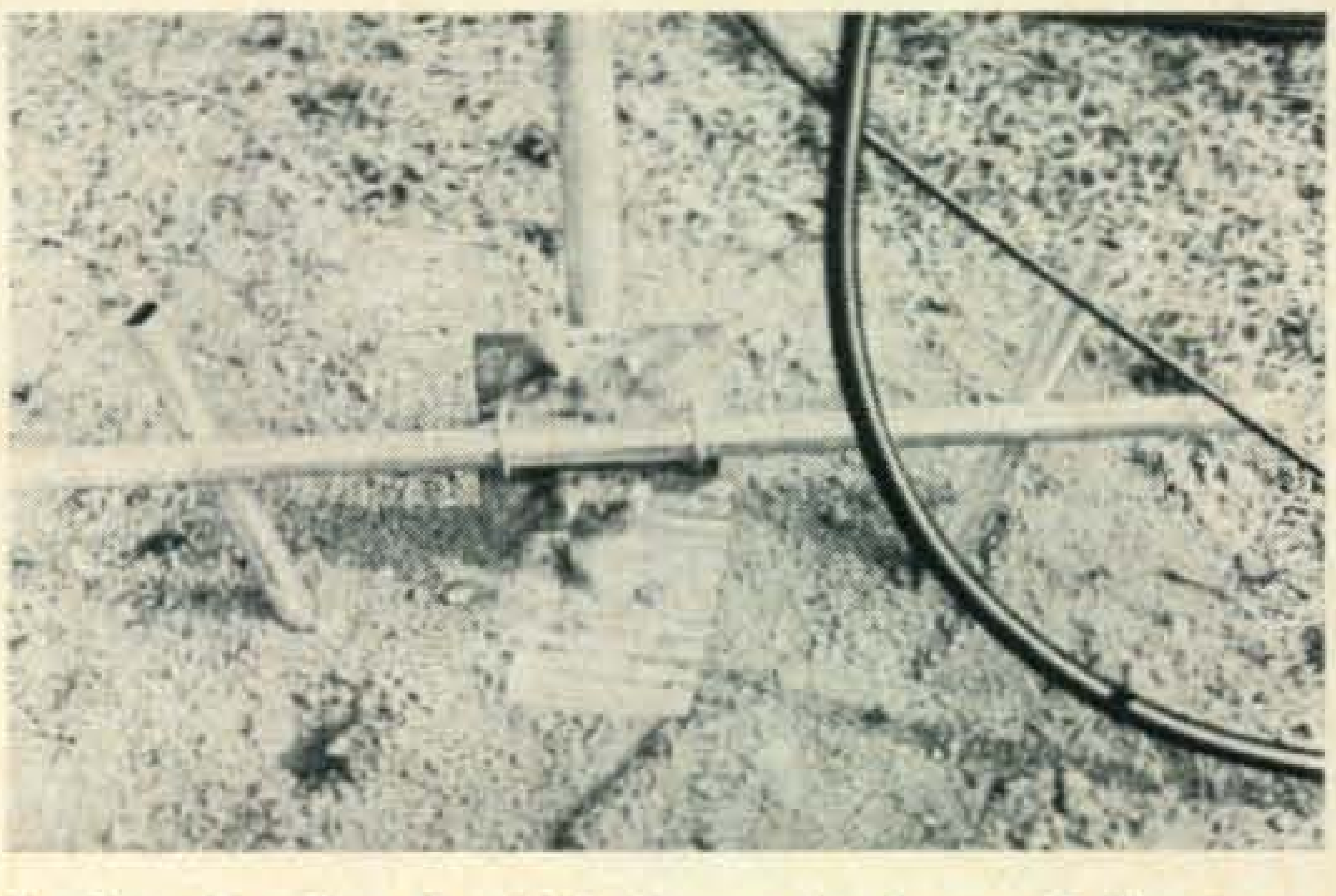


Close up view of the dual rotator mount. Note the use of the end plate as a bearing for the elevation rotor. The pipe projecting out over the side is for the counterweight.



A view showing the U bolts at the base of the mast.

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See Page 103 May issue for ANTENNA Roundup II.

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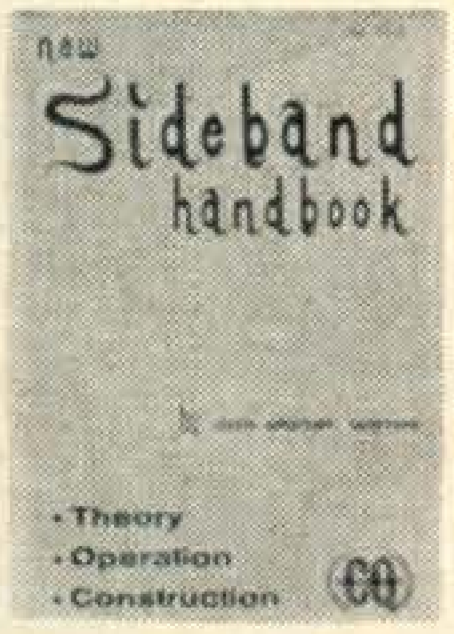

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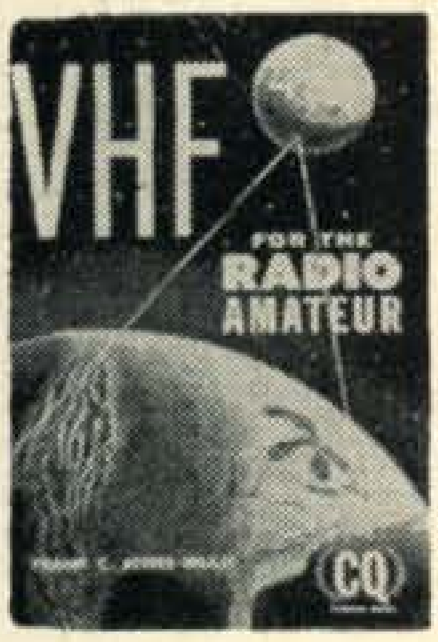

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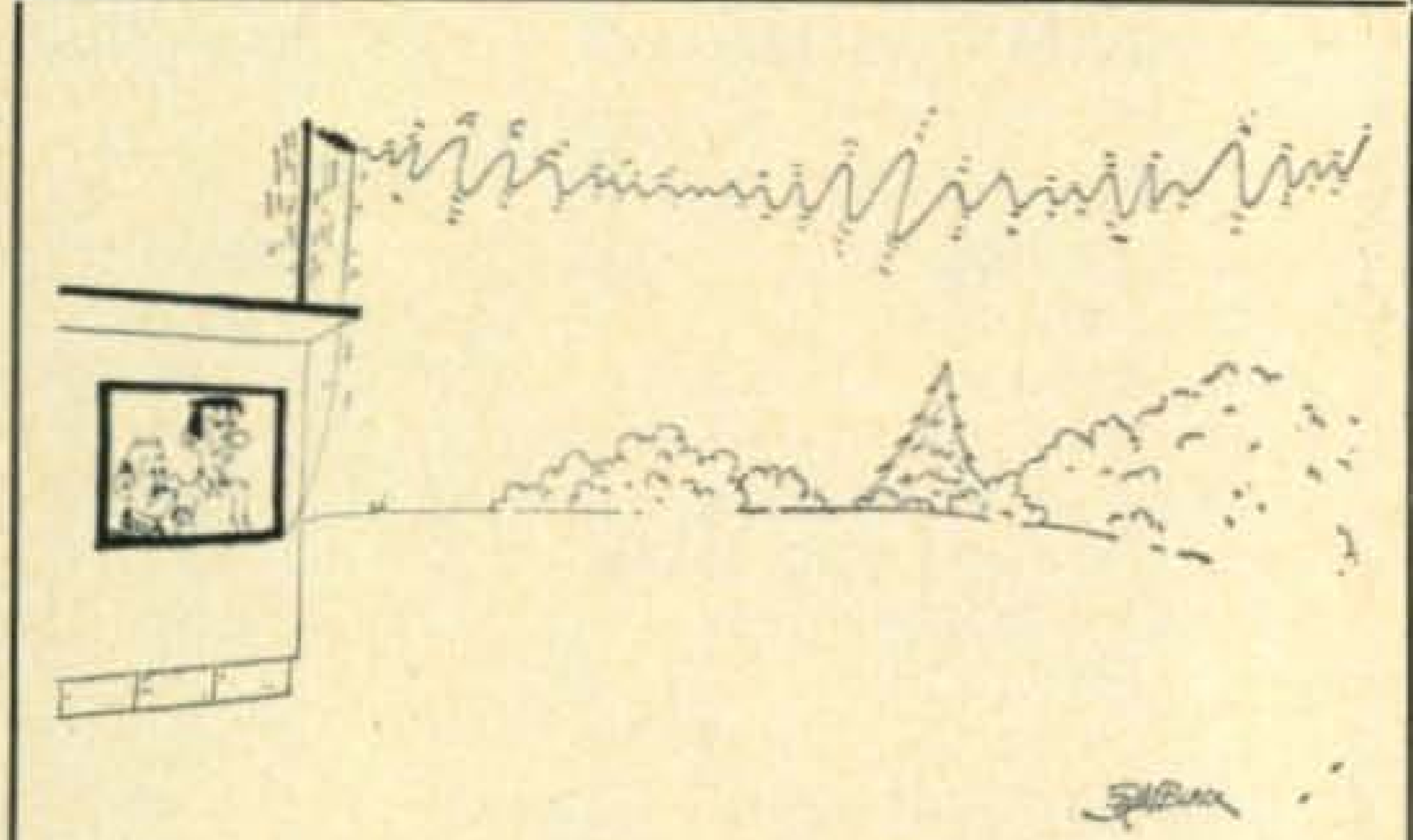

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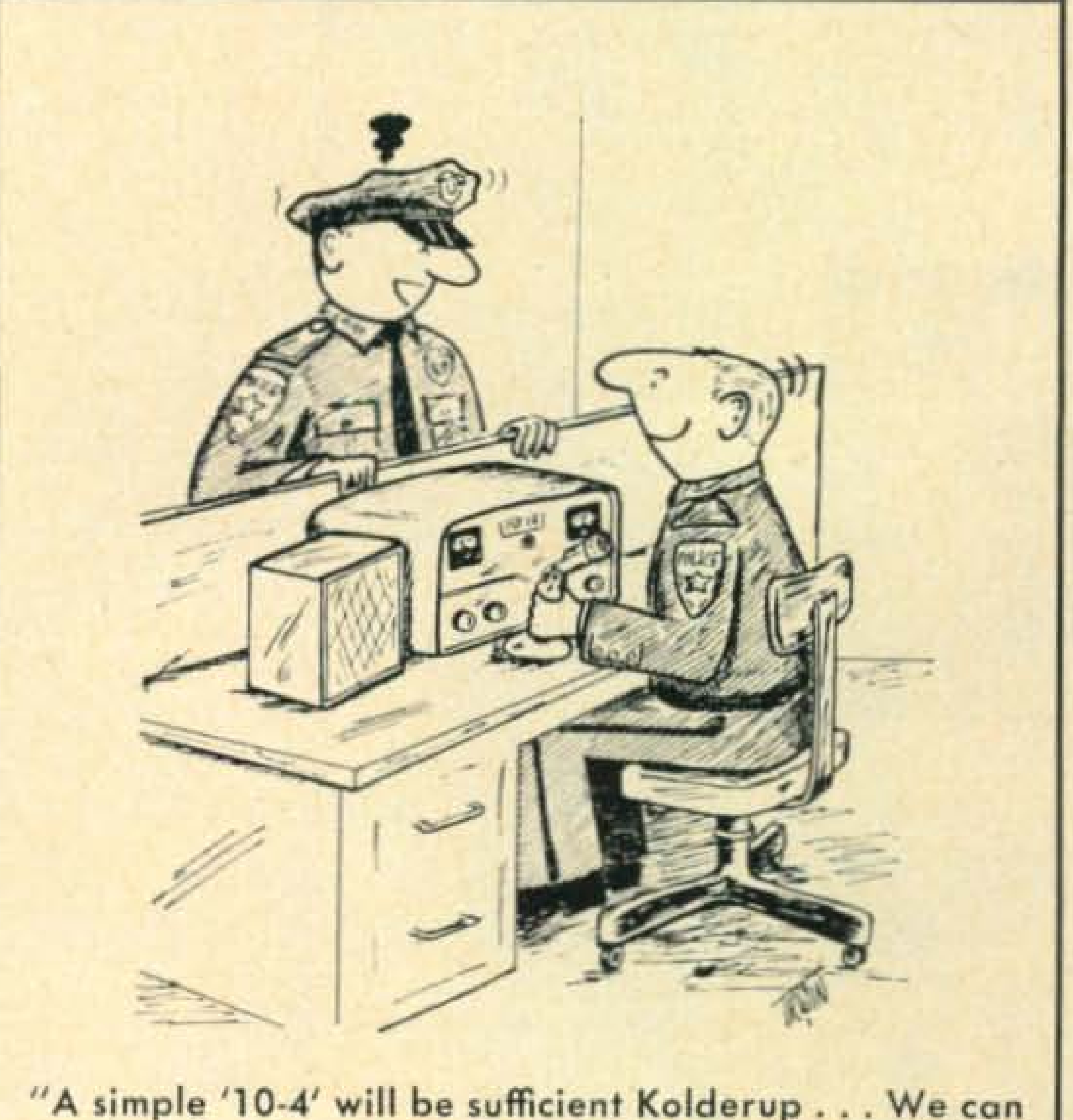

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A CHEAP AND SIMPLE ANTENNA FARM

BY GEORGE COUSINS,* VE1TG

The main antenna consists of stacked 8JK sections that operate on 20, 15 and 10 meters. The guys for the mast are inverted vees for operation on 40 and 80 meters. The entire installation is fairly compact and rather inexpensive.

THE antenna system to be described here was the result of a move to a new QTH, this move being one of a great many which I have made over the past years as a result of work assignments. Since most of these moves have been of a short duration, there has been the constant problem of trying to get on the air in the fastest and simplest way possible. However, because of wanting to work DX and contests, there were several requirements which had to be met: all band operation from 80 to 10 meters, and efficiency—especially a reasonable amount of gain on the 20, 15 and 10 meter bands. Being a temporary QTH only, the system also had to be cheap enough that it could be built, used and if necessary, discarded at the end of the period without much loss of money. Looking back on the whole thing, the final result cost very little and should be of interest to anyone with the urge to get up an excellent all-band system with a minimum of cost. Of course, there have to be some compromises—for example, no rotators are used, so some directivity has to be sacrificed. However, as will be seen this is not a great disadvantage.

The main component of this system is a compact, four element all-driven array which works on 10, 15 and 20 meters—and also on 40 meters for that matter, though its gain or directivity on this band is not too pronounced. Old-timers will recognize it as a pair of 8JK arrays stacked and fed together. Figure 1 shows the basic diagram for a single section 8JK, in which the length is made about 33 feet and the spacing about 8 to 8½ feet. The two elements are connected in the center by a transposed section of line, and an open wire transmission line is connected to the center as shown.

By the use of tuned feeders, this simple array will work well on the three bands, as many a ham has found out in the past. The array can be hung either horizontally or vertically, and the cost is practically nil. However, even though this array is very effective and gives several db of gain, its performance can be increased considerably by stacking a second array under the first, and feeding the two together. Again, the low cost of materials makes this a practical thing to do. The supporting structure must be higher of course, but not to the extent of being either costly or unmanageable.

Mast Construction

The final design which was used at VE1TG is shown in fig. 2, at least as far as the 8JK array was concerned. Since the antenna itself is a simple thing to construct, the first attention should be paid to the supporting structure. There are occasions when one might have a couple of trees or the good fortune to have a telephone pole or two, but in this case the antenna had to be erected on a barren hillside, exposed to the ocean and constantly swept by high winds. So the masts had to be made up from scratch.

As shown in fig. 3, each mast is made up from three lengths of lumber. Most hams are familiar with the simple "A" Frame type of construction, and this could be employed very well. However, the style shown will also prove to be very sturdy. Bearing in mind that the antenna should be at least 15 feet high—from ground to the bottom elements—select lengths of lumber that are as solid and knot-free as possible. Having had rather dubious success in finding good clear lumber in the lengths desired, and bearing in mind the cost factor, I would suggest going to the local yard and look over what is available. Most yards will let you measure and puzzle to your heart's content, knowing that you will undoubtedly buy at least something before you leave. In the average small-town yard I think that about 16 or 18 feet is the maximum length you will find readily available. I would strongly suggest using 2 × 4, but if you wish you can use 2 × 3 or even 2 × 2. But remember, although you will only be supporting light wire, in a high wind the strain on the masts is multiplied by the whipping and pull of the elements, and so select the wood accordingly. The extra cost for 2 × 4 is well worth while.

In addition to the long lengths, a quiet chat with your friendly lumber dealer should enable you to get a few bits and pieces of 2 × 4 at a very reasonable figure, as well as two pieces about 8½ feet long to use for the spacers on the bottom elements.

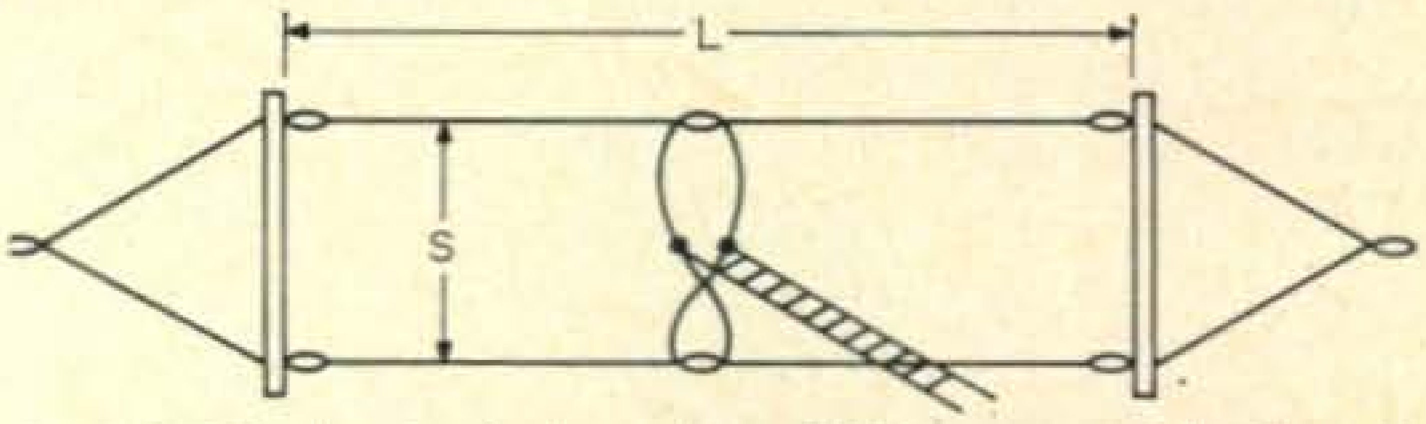

Fig. 1—The basic design of an 8JK antenna. The length is between 33 and 40 feet with an 8½ foot spacing.

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*RR2 Lower Sackville, Nova Scotia, Canada.

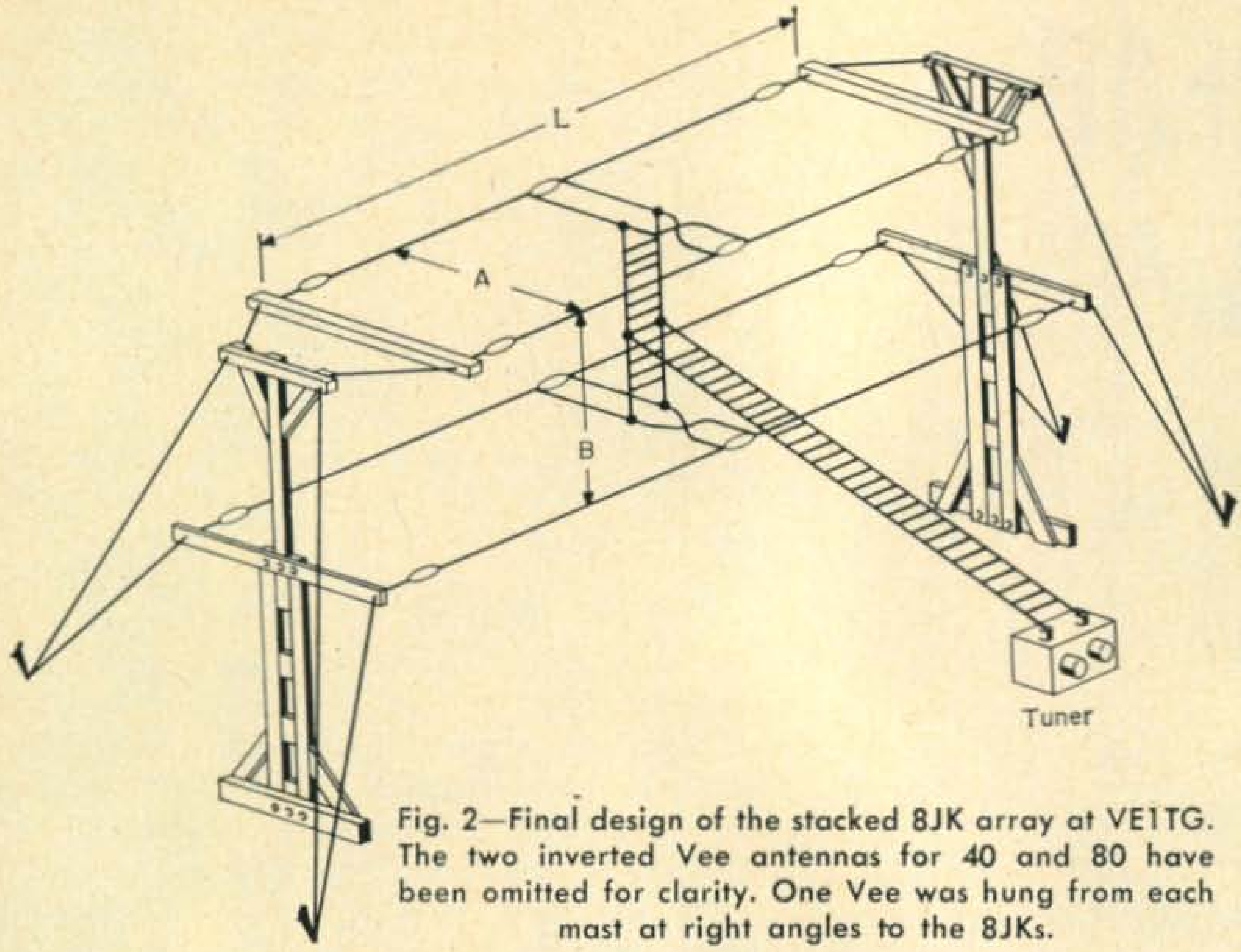


Fig. 2—Final design of the stacked 8JK array at VE1TG. The two inverted Vee antennas for 40 and 80 have been omitted for clarity. One Vee was hung from each mast at right angles to the 8JKs.

Make sure the wood is dry and free from grease or other material, and then give the long sections at least one coat of good exterior paint. Use aluminum paint if you can afford it, as it will give considerably better protection to the wood. Buy it in the gallon size—it's cheaper that way, and you'll use most of it if you do a good job on all the wood.

By laying the long lengths out on a couple of saw-horses, the mast can be assembled very easily. Two good sturdy bolts, about ½ × 6 inches, should be used at point *A*. They should be galvanized or brass, especially in a salt-air region. Allow about a 2 foot overlap at point *A*. Several strengthening blocks should be inserted to hold the bottom 2 × 4's together and in line. At the base, a length of 2 × 4 about 4 to 6 feet long is spiked as a foot, with side braces from the outer ends of the foot to the mast. This foot arrangement is of great value in holding the base steady when the mast is being raised. By driving a piece of pipe into the ground and tieing the base to the pipe, the mast can be raised easily since the foot will not slip out from under, and the width of the foot will help prevent the mast from tipping to one side.

At point *A*, the 8½ foot cross-piece should be bolted to the mast on the opposite side of the mast from the antenna itself. This will give maximum strength. At the top of the mast, a 4 foot length of 2 × 4 is bolted and braced. This will be used to hold the top elements and their spreaders.

Considering the fact that the masts are best raised one at a time, and the antenna put up later, some arrangement must be made for hoisting the elements into place. A small pulley should be placed at the outer ends of the cross pieces but considering the usual cost of brass pulleys, satisfactory results can be obtained by the use of large eyebolts which can be fastened securely to the wood and small diameter rope passed through the eye. The best bet here would be the light weight synthetic fiber ropes although almost anything in the line of clothesline rope of something similar would do.

After two masts are completed, and the hoisting ropes put into place, some thought should be given to the erection site. Providing that space is available, and remembering that the array is bi-directional, the antenna should be placed so that one lobe will be firing in the direction in which one is most interested. In my case, I hung the antenna in a fairly north-west to south-east direction. Considering that the element length will be from 33 to 40 feet, one should decide on the exact length he is going to use, then allow a few feet extra for insulators, spacers, etc. and mark the positions of the two masts. If an extra body or two is now available, the masts can be stood up and guyed in place. Giving a quick glance back at fig. 3, it can be seen that when the array is in place the hoisting ropes can be used also as guys on the outside of the masts, while the array itself will serve as an inner guy for both masts. Therefore, only minimum guying will be required to hold the masts vertical until the antenna can be installed.

The Array

The construction of the array is quite easy. Measure off the four elements, which will be essentially nothing more than four 20 meter dipoles, except that the length of each can be anywhere from 33 to about 40 feet. However, each one should be the same length as the others. Wire size should be at least #14 from the point of view of strength. Twelve insulators will be required, and in my case I bought a piece of ¾ inch hardwood dowel, sawed it into 6 inch pieces, boiled them in paraffin and used them

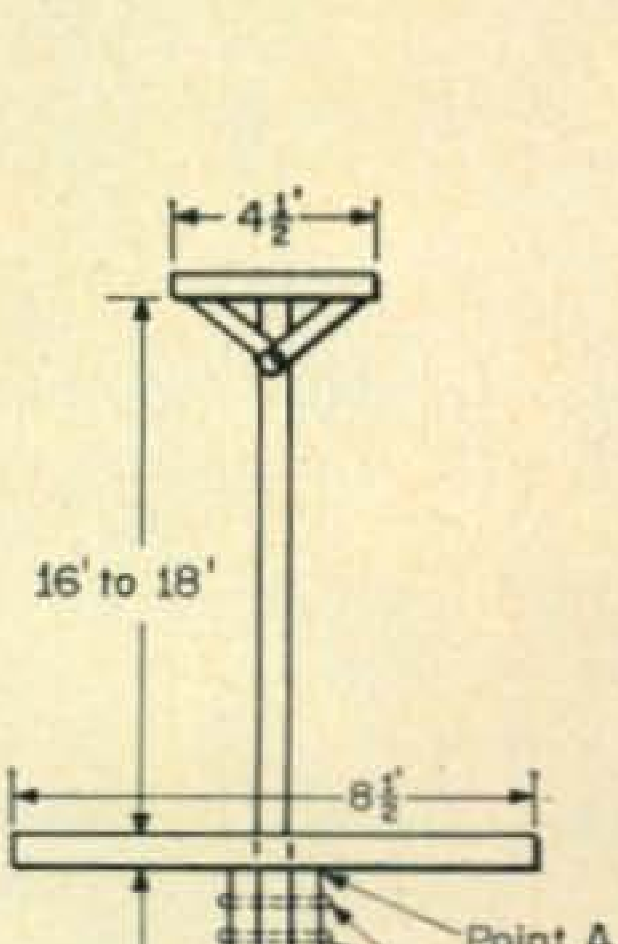


Fig. 3—Construction details of the two masts. Materials can be 2 × 2, 2 × 3 or 2 × 4 but 2 × 4 is strongly recommended. If desired, the masts can be constructed A frame style instead.

instead of regular porcelain types. I must point out that this was a matter of necessity since otherwise I would have had to order insulators by mail and I didn't want to wait.

Some thought must be given to the center spacer of each single array, in order to achieve proper transposition of the wires without shorting them together the first time the wind blows. Figure 4 shows my own method, with a piece of ½ × 1 wood used as the spacer and the center dowel insulators running right through the wood. Two small stand-offs complete the structure and the wires are supported well apart from each other. All wire joints should be well soldered. In places where the open wire type of TV lead-in is available, the transposing wires and connecting leads could probably be made from this, and would result in some saving in weight and probably also be neater in appearance.

Some care must be taken in erecting the array. The top elements should be hoisted up clear of the ground and the connecting line attached to the bottom elements. The open wire line leading to the shack should also be attached, at a point midway between the upper and lower elements. This line can be TV ladder-line, or can be homemade by using light hardwood dowelling and almost any wire that is available. The homemade line should be spaced from 4 to 6 inches.

By patience and some running back and forth, one man can easily assemble the whole array and get it into its final position. In the case of the top elements, I used a light wooden spreader on each end, and this arrangement can be easily seen in fig. 2. After the hoisting ropes have been fastened to stakes in the ground the whole affair will be found to be very solid. Of course, like most antenna structures, the quality of the overall product will be only as good as the material and workmanship which went into it.

Feedline

It is always nice to be able to run the lead-in away from the antenna at right angles; however, in my QTH I wasn't able to do this and probably this will be the same with most people. There did not seem to be any noticeable deterioration of performance by the lead-in coming out at an angle.

Feeding the array, of course, requires an antenna tuner, which could be something of the Johnson "Match-Box" type, but can also be made up very cheaply out of junkbox components. Many satisfactory designs have been shown in magazines and handbooks, but I personally have had excellent success with the all-band tuner shown in the ARRL antenna handbook, and diagrammed in figure 5. The procedure for setting up the tuner is given in any handbook, and since the vast majority of transmitters today are of the pi-network output type, an s.w.r. meter should be considered an absolute necessity for initial tuning up. Once the proper setting for the capacitors are found, a pair of dials can be added and the various band settings carefully marked. Then the s.w.r. meter can be removed or, if borrowed, can be returned to its owner. With this tuner, it is readily possible to get the s.w.r. in the coax link line down to a 1:1 ratio or very close to it. However, considering the variables involved, two capacitors in the pi-network and two more in the tuner, the initial tune-up can easily be a slow and frustrating experience. It may be necessary to experiment with the length of the feedline though this should not normally be tried until one is absolutely sure the tuner will not operate properly.

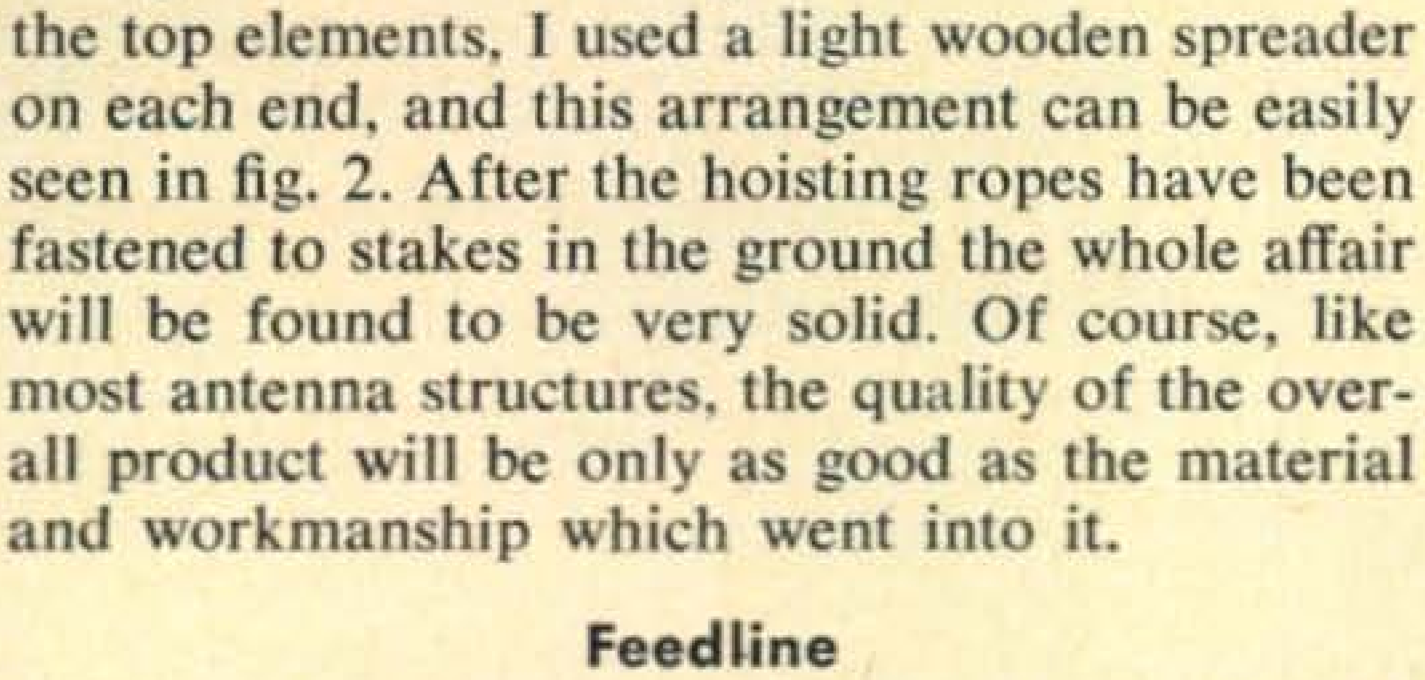


Fig. 4—Method of building the center spacer for the 8JK elements.

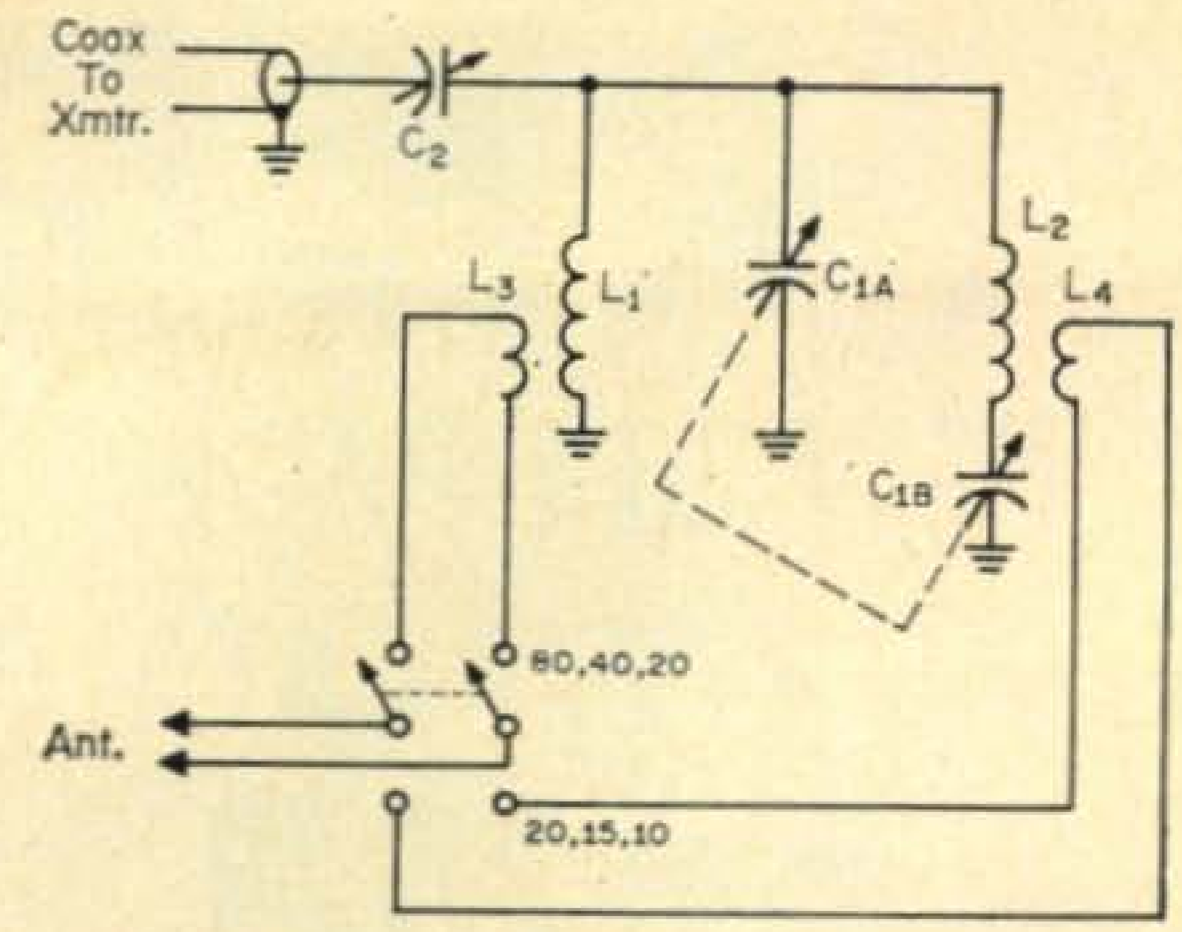
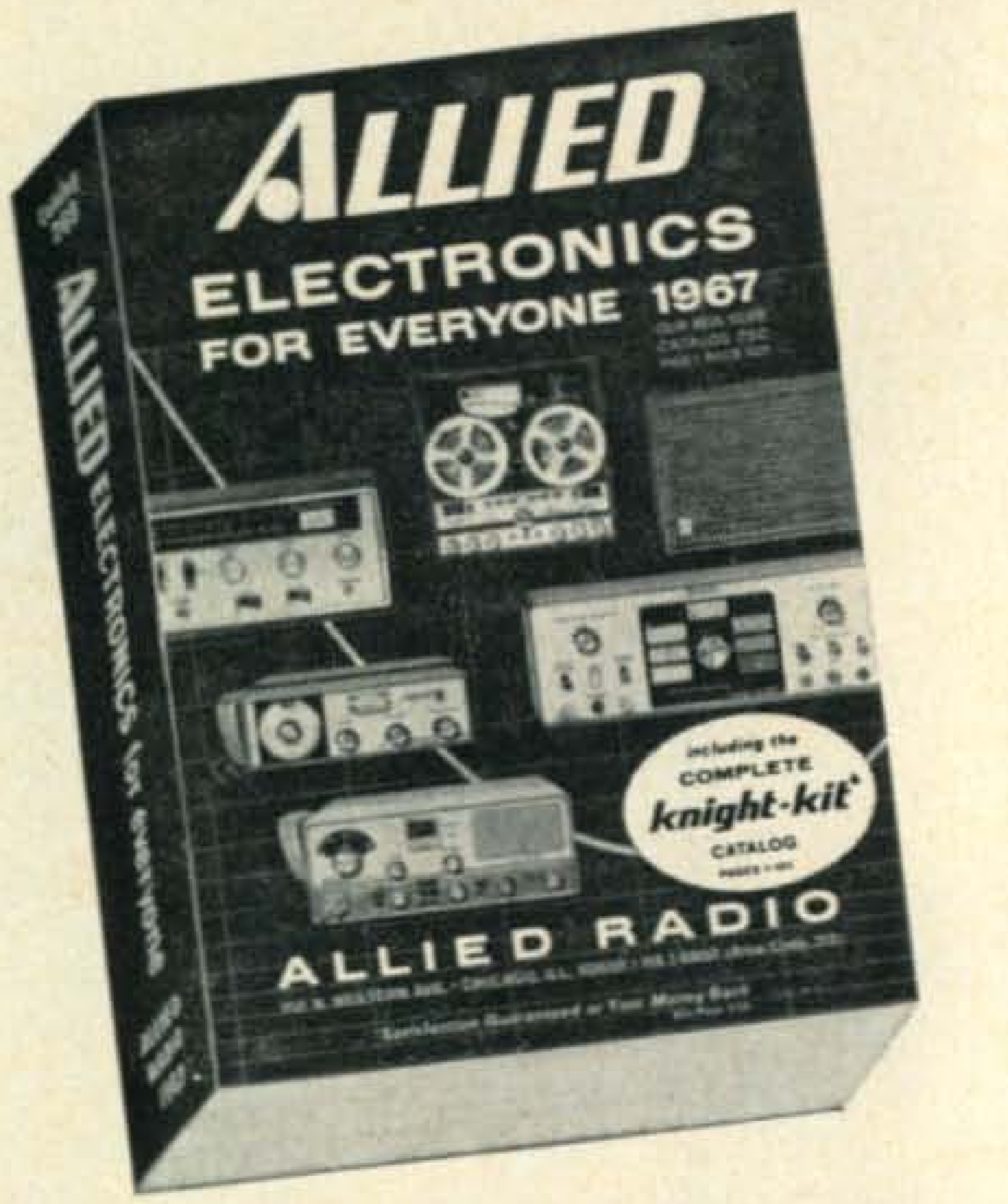


Fig. 5—Circuit of the tuner used with the 8JK array. The coils are wound on ceramic forms taken from an old BC-375 tuning unit. The coax series capacitor is taken from the v.f.o. section of a TA-12 transmitter and $C_{1A \text{ and } B}$ is a unit with spacing large enough to handle the power of the transmitetr used.

C_1—350 mmf per section.
C_2—400 mmf.
L_1—11t #12, 2" o.d., 2¾" long.
L_2—5½t #12, 2" o.d., 1¼" long.
L_3—6t #12, 2½" o.d., 1½" long.
$_4$—5t #12, 2½" o.d., 1¼" long.

Performance

After tuning the array up on 20, 15 and 10 meters, and finding results to be very satisfactory, I tried an experimental tune-up on 40 meters. To my surprise, the array tuned very well indeed, and a few minutes later I was having a chat with 5N2JKO in Nigeria, which is quite an acceptable test of any antenna on 40 meters. It also proved very satisfactory for working into Europe and South America so operation on 40 should be considered as an excellent bonus. As a matter of fact the tuner will load the an-



tenna on 80 meters but all I used it for on this band was local rag-chewing so how it would be for DX is questionable.

Having no equipment for accurate gain measurements, the best that I could do was consider all the published data I could find on the 8JK then make some allowances for element length, height, etc. However, it seems likely the gain would be about 6 db. Regardless of actual figures, I found the antenna gave really excellent performance, and certainly left little to be desired. There is the problem of fixed directivity of course, but the lobes are not extremely sharp and in actual practice it is capable of good results even off the ends. The small disadvantages are outweighed by obvious good features of low cost and multi-band operation with good efficiency. If the band is even barely open, this antenna will make itself heard.

Inverted Vees

In actual fact, the antenna is designed only for 20, 15 and 10 and operation on 40 or 80 is not really normal, even though in my own case I found it could be done with good results. However, just to be sure, I completed the "farm" by using the two masts as the supporting point for an inverted Vee for both 80 and 40. Using one mast for each antenna not only provides good physical separation, but also provides an extra set of guys for the mast itself. The inverted Vee is well known and the construction is very simple. I used separate feed lines made of RG-59/U coax (72 ohm) because this line is considerably cheaper than the heavy RG-8 or RG-11, and is quite adequate for medium power transmitters. A saving could be accomplished by mounting both antennas on one mast, and feeding them in parallel with one piece of coax. However, I do not personally favor this arrangement because of the ease with which the second harmonic of 80 meters can be transmitted by the 40 meter antenna unless some sort of harmonic trap or tuning network is employed.

The final result is an all-band set-up which will be very efficient and at the same time be just about as low cost as a reasonably good antenna farm could be.

Perhaps it might be well to point out that a simpler arrangement can be made by using only, one section of the 8JK. The masts will be the same basic construction, but could be lower, and the feedline would be connected to the mid-point of the transposed line between the elements. The same tuning network can be used, and results will be very good, though, of course, there will not be quite as much gain or directivity. ■

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Finished station showing output diplexer on wall and input diplexer coiled and placed on desk. The small 50 ohm terminating resistor may be seen on the input diplexer. The panel at the lower right is the pi-network used between the diplexer and the antenna. Although shown with the HW-32 in this photo, the paralled amplifiers required considerably more drive than it could provide.

2000 WATTS P.E.P. AT 10¢ PER WATT

BY ROBERT E. KUHNERT,[†] K3BRE/8 AND W. H. COLLINS,[*] W8DQI

Combining the outputs of two 1 kw p.e.p. linear amplifiers to provide 2 kw p.e.p. can be accomplished using the diplexer units described below.

THOUSANDS of amateurs get along very nicely using low power in the crowded h.f. bands. Most, however, get the urge at some time to try out a man-sized pair of shoes. So it was when the authors saw the Heath HA-14 "Kilowatt Kompact" linear amplifier. We decided "now is the time." The HA-14 is rated at 1 kw peak envelope power (p.e.p.), is quite inexpensive and is amazingly compact. A *pair* of them will run 2 kw peak, the nominal legal limit. The trick then, it was decided, was to buy two and combine their outputs in phase to provide that 2 kw pair of shoes.

The method used is simple, versatile, reliable and it worked the first time—no cut and try or experimenting. The method is adaptable to any pair of identical amplifiers. Provision is made for reducing power from 2 kw down to barefoot operation in approximately 6 db steps when the big shoes aren't needed.

What About That One KW Limit?

Some may wonder how we can brazenly admit running 2 kw when anyone knows the legal limit is one kilowatt. The answer lies in the distribution of envelope power level in speech. The average power of uncompressed speech is 10 or 12 db less than the nominal peak. So, a Class B linear amplifier running at 2 kw peak will run only 200 watts or so average power input on speech. (This, by the way, explains the small power supplies used these days for some high power linears, such as the HA-14, HP-24 combination). Add a little speech compression or automatic load control and the average power will increase while the peak power remains the same. Meters reading power input won't read either peak or average, but something inbetween. All these factors combined may result in an ap-

---

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[*] 2704 Grand Avenue, Middletown, Ohio 45042.

parent "peak" power input of about 800 watts as indicated on the plate current meter when the amplifier is actually running 2 kw peak. According to the meter readings, then, the power input is less than 1 kw and therefore legal.[1] It could also be pointed out that an ordinary 1 kw a.m. rig runs 4 kw p.e.p. when 100% modulated.

Whatever argument is used it is clear by looking through various ads in this magazine that many 2 kw linears are for sale these days. They are legal, and usually a great deal more expensive than our approach to high power, described in this article.

The Paralleling Method

As a start we can say that in order to parallel two amplifiers we need to be sure that we connect them at points of equal r.f. phase and equal envelope delay, and they must be isolated from each other to prevent distortion, feedback, or oscillation.

These requirements are simply met when a diplexing network is used. It is constructed of coaxial cable as shown in fig. 1, and connected as shown in fig. 2. The transmission lines connecting the linears with the diplexers must be equal in length in order to preserve equal r.f. phases.

We will describe how it works a little later. However, at this point we will explain what the diplexing network does. When two power sources of equal frequency, phase and power level are connected as shown, their output power is combined at the antenna connection. Both linears have a 50 ohm load and there is negligible coupling or cross feed of power between them. Power dissipated in the 50 ohm terminating resistor at *D* (fig. 1.) is zero, with all of the power being fed into the antenna. Should the r.f. phase or power level of one amplifier vary slightly the result will be a small amount of power going into the terminating resistor at *D*. Isolation between amplifiers remains unaffected.

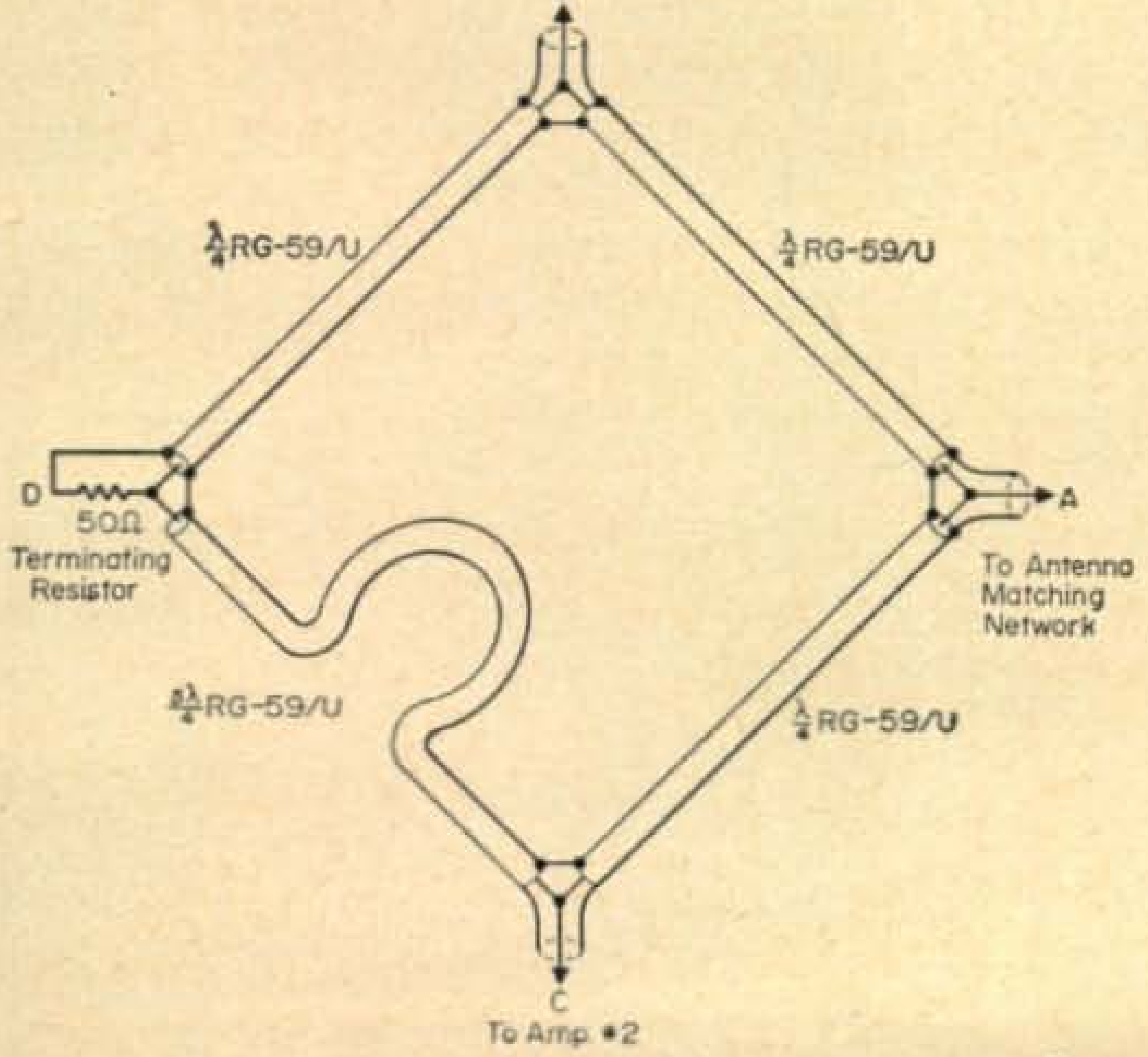

Fig. 1—Diplexer for combining the power output of two linears without phase and distortion problems.

If either amplifier is turned off the other continues to see a 50 ohm load. Half of the remaining power goes into the antenna at *A* and half into the terminating resistor at *D* resulting in a 6 db or one S unit drop in output power, as compared with the two-amplifier case. (Note: S units seem to vary from 3 to 6 db depending on receiver manufacturer).

The input diplexer between the exciter and the amplifiers works the same way, but in reverse. It splits the exciter power evenly and minimizes load variations on the exciter if one amplifier is turned off.

The Heath HA-14 amplifier, like many others available today, has a relay which connects the r.f. straight through when the linear is turned off. One might expect serious problems of feedback to result if one amplifier were turned off, thus connecting together the output and input diplexers on one side. The isolation from *B* to *C* on both input and output diplexers, however, is sufficient to prevent any complications whatsoever when this happens. Furthermore, if both amplifiers are turned off the exciter output is simply split, recombined again and fed into the antenna with no power loss in the loads at *D*. The send-receive relay in the exciter can still be used as usual with the above process reversed and the received signals coming back through both diplexers and linear bypass relays.

The 50 ohm terminating resistor at *D* in the output diplexer must be capable of dissipating one half the average output power of one linear amplifier if you intend to operate on one amplifier at times, or in event one amplifier fails for some reason. A load constructed to dissipate 50 watts is sufficient. If you use speech compression this should be increased accordingly, perhaps to as much as 200 watts.

The terminating resistor at *d* on the input diplexer must dissipate only half the exciter average power at most. A combination of four 2 watt resistors resulting in 50 ohms was adequate for us.

Antenna Matching

Proper operation of the diplexer requires either a 50 ohm impedance looking toward the amplifiers at *B* and *C* (a condition which is seldom satisfied in a linear amplifier output circuit) or a 50 ohm load at *A*. An antenna matching network is therefore used to assure exactly 50 ohms at point *A* on the output diplexer. An ordinary pi-network was used for this purpose as shown in fig. 3. Properly shielded, it also provides additional TVI protection.

Theory Of Operation

Theory of operation of a diplexer can be understood without a lot of complicated mathematics. Referring to fig. 1, let's take two cases.

Case 1. Let two amplifiers with output voltages equal and in phase be connected to points *B* and *C* of one of the diplexers. The voltage at *B* is transformed down line *BD* ¼ wavelength and the voltage at *C* is transformed down line *CD*

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[1] Add driver power input to final power input for g.g. operation.

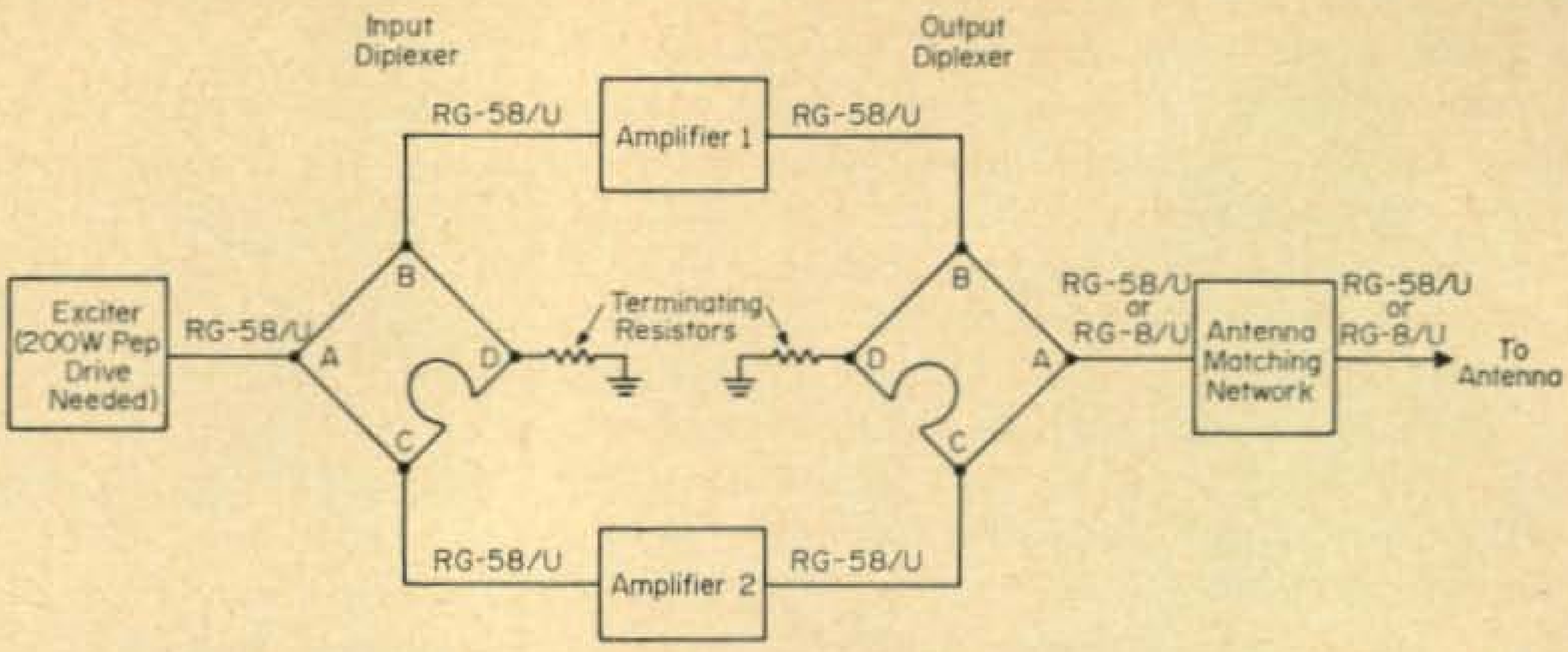


Fig. 2—Block diagram of the entire system showing both input and output diplexers. Regard the letters A, B, C, D in the input diplexer as a, b, c, d.

¾ wavelength, the two components arriving at point D exactly 180 degrees out of phase. Since the voltages at *B* and *C* are equal they cancel at *D* to give zero volts at D. Therefore, no power is dissipated in the terminating resistor. Connecting points *B* and *C* with the one wavelength line *BDC* is electrically the same as connecting points *B* and *C* directly together. It is obvious that if the voltage at two points is equal and in phase no current will flow between them if the two points are connected together. Since no current flows in line *BDC* it can be ignored in this case.

The 50 ohm load at *A* may be considered to be two 100 ohm resistors in parallel, or each separately connected to lines *BA* and *CA*. Lines *BA* and *CA* have a 73 ohm characteristic impedance and act as quarter-wave transformers which transform the 100 ohm loads to look like 50 ohms at points *B* and *C*. Each amplifier is therefore loaded into 50 ohms and their voltages add at point *A*, the load.

Case 2. Let an amplifier be connected to point *B* with nothing connected to point *C*. Line *DCA* is one wavelength long connecting point *D* to *A* which, as before, is the same as connecting them together. As before, no current flows in this line so it can be ignored.

The 50 ohm load at *A* and 50 ohm terminating resistor at *D* are each transformed to 100 ohms at *B* by the quarter-wave transformer and these two 100 ohm impedances in parallel at *B* again make 50 ohms for a load on the *B* amplifier. Note that half the power goes into the terminating resistor *D* and half into the antenna. Note, also, that the voltages at *D* and *A* will be equal and in phase.

Getting back to line *DCA*, the voltage at *C* is zero since the components arriving from *A* and *D* are 180 degrees out of phase and cancel. If the voltage at *C* is zero it follows that any impedance, including a short circuit to ground, can be connected at *C* with no effect on the circuit. If the voltage is zero it is also true that there will be no feedthrough of power from *B* to *C*. An amplifier connected at *C* will therefore be independent of one at *B*, yet the output of each will add at A.

A similar investigation will show that the voltage at *B* will be zero when a single amplifier is connected at *C*.

Construction

The heart of the 2 kw p.e.p. Parallel Linear Amplifier System is, of course, the diplexer. Each diplexer consists of four lengths of RG-59/U coaxial cable, three of them one-quarter wavelength each and one three-quarter wavelength section. The RG-59/U lines are connected in bridge fashion as indicated in fig. 1. Physical positioning may suit individual likes or space available.

The coaxial cables used may be of the small variety *i.e.* RG-58 and RG-59, in their proper places since with *s.s.b.*, transmission lines should be selected considering the *average* power and the *peak* voltage to exist on the line. The average power and peak voltage ratings of these small lines is quite adequate even at 2 kw p.e.p.

We used a different arrangement for the two diplexers as seen in the photos. Our input diplexer is mounted on a one-square-foot board with all phasing lines coiled on top of each other. Connections for exciter input and terminating resistor are SO-239 coaxial chassis jacks. Leads to each linear amplifier, made of RG-58, are soldered to the proper coaxial sections at points *b* and *c*. (See fig. 2.) The length of the leads to the amplifiers is not important, but they should be the *same*. For our project they were made five feet long to permit stowing the diplexer under a table or behind a desk. Phono plugs are put on the ends of the RG-58 leads to mate with the r.f. input jacks on the HA-14 amplifiers.

The output diplexer was mounted on a peg board as shown in the photograph. This arrangement is primarily to illustrate the construction, but it does permit easy stowing on a wall, behind a desk or in any other convenient place. Plastic cable clamps hold each coiled section in place and on this diplexer each coax section is terminated in a SO-239 coax jack except for the terminating resistor end. Shields of the coax

20 Meters	$\lambda/4$	$\frac{3\lambda}{4}$	v
Amphenol RG-59/U	11′ 2″	33′ 6″	65%
Polyfoam RG-59/U	12′ 8″	38′	73.5%

Table I—Phasing line lengths and velocity percentages for two types of coax.

phasing lines at *A*, *B* and *C* (see fig. 2) are soldered to the SO-239 bases to insure good connections.

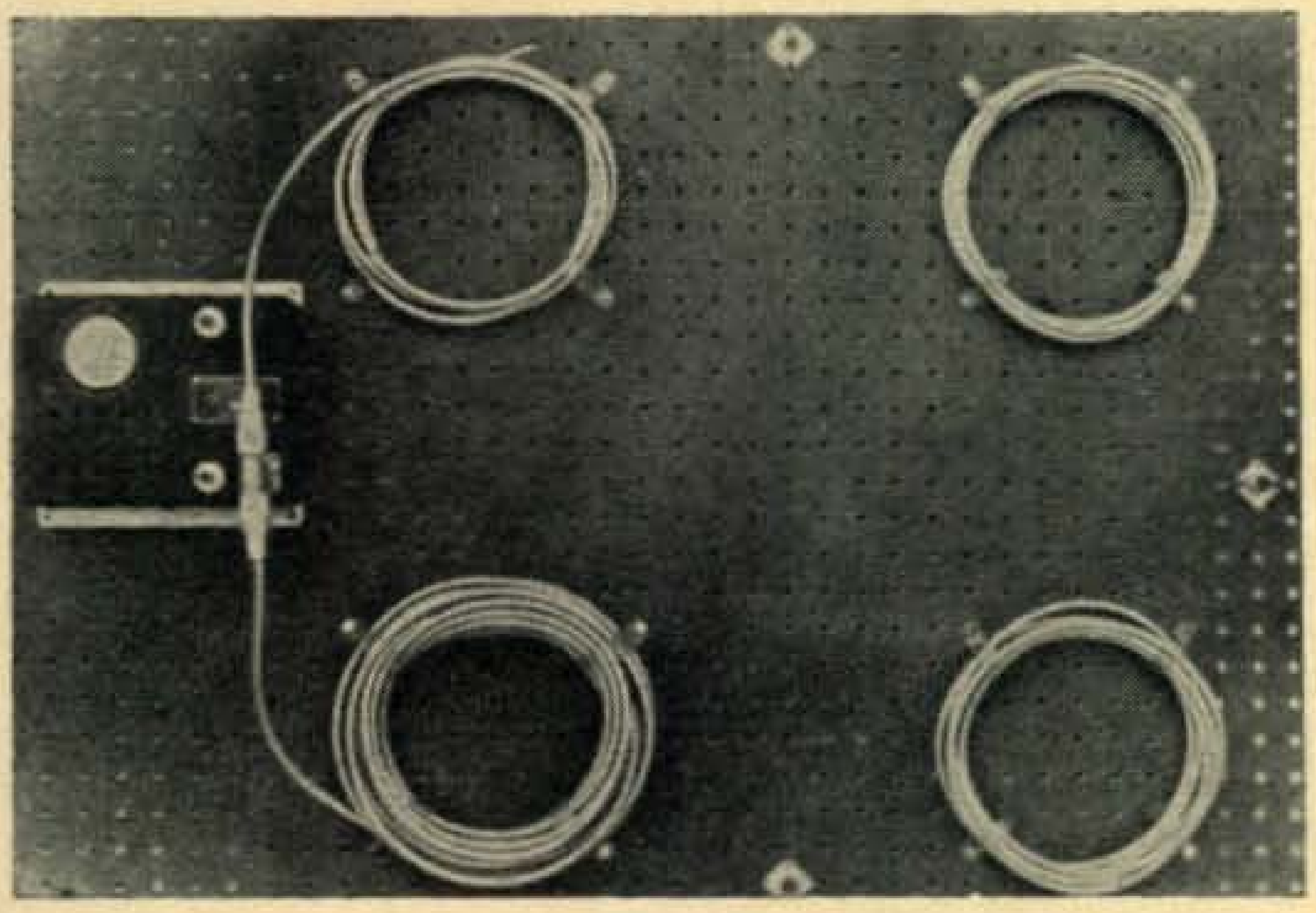
At the terminating resistor end of the output diplexer PL-259 coaxial plugs—with UG-176/U inserts—were connected to a M-358 coaxial "T" connector on the terminating resistor which is any 50 ohm load capable of dissipating 50 watts. The one used was an old military surplus dummy load available in the parts box and internally modified to give 50.0 ohms at 20 meters. The terminating resistor at *D* on the input diplexer was made from a short stub of RG-8 with parallel 2 watt resistors equalling 50 ohms—or as near it as possible—soldered on one end and a PL-259 on the other.

Cutting of the quarter-wave and three-quarter-wave sections of RG-59 should be carefully and precisely done to a selected frequency. We decided on the 20 meter band and 14.3 mc as our frequency and cut the sections to that frequency. A calibrated receiver and a grid-dip oscillator are needed for phasing line preparation. The lengths of RG-59 used will depend on the type of coax selected. We used both the usual polyethylene line and the new foam line. The final lengths used are shown in Table 1. For other frequencies the length of a quarter-wave can be calculated as:

$$L = \frac{2.46 \cdot v}{f}$$

Where: f = frequency in mc.
v = coax velocity of propagation, in percent (see Table I).
L = length of a ¼ wave, in feet.

Due to variations in commercially available lines it is best to check out each section with a grid dipper to be sure of the electrical length. Start with a foot or two longer than the length calculated or shown in the table. With the braid peeled back and twisted on one end, form a small pick-up loop by connecting the braid to the center conductor. Leave the other end open circuited. Couple the grid dip meter to the coax end loop and tune for a dip. Couple loosely enough for just a slight dip. Without changing the position or coupling of the grid dip meter and coax, tune the receiver until the oscillator frequency is found. This is the resonant frequency of the RG-59 stub which should be below the desired frequency before pruning. Prune a short piece off the open circuited end of the RG-59. Each time a piece is pruned dip and check the frequency of the meter with the calibrated receiver. As the desired frequency is approached pruned pieces should be smaller until a fraction of an inch is cut off. Patience in the preparation of the sections will result in a well-matched set of phasing lines.



Wall mounted Diplexer showing terminating resistor in black box at left, output connection at right and connections at top and bottom for the amplifier outputs. The large coil at the lower left is the ¾ wavelength phasing line.

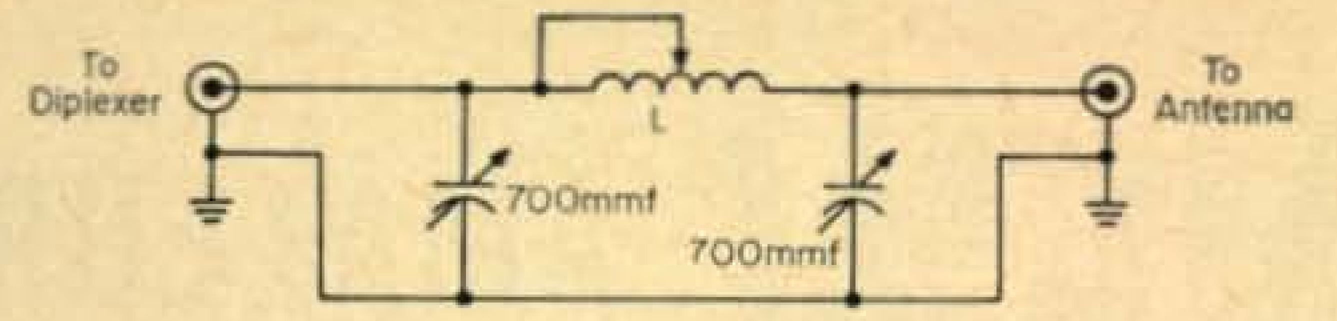


Fig. 3—Circuit of the pi-network used to maintain a 1:1 s.w.r. The capacitors are 700 mmf maximum each, and coil L is a suprlus variable unit from an SCR-274N.

The diplexers are sufficiently broadband to permit frequency excursions across the amateur band for which they are designed with no effect on power output or s.w.r. If touching up is desired the outboard pi coupler can quickly and easily be tuned for zero reflected power on the s.w.r. meter in the amplifier.

Two lengths of RG-58 may be used to connect the outputs of the two linear amplifiers to points *B* and *C* on the output diplexer. These cables may be any length needed, but both *must* be the same length. The same is true for the cables connecting the input diplexer to the amplifiers.

Construction of the "outboard" pi coupler is simple and inexpensive if one has access to a good junk box or a surplus parts store. The variable inductor can be one from SCR-274N type transmitters, and variable capacitors can be picked up inexpensively at surplus houses or bought new. A simple pi-network coupler will keep the linears happy by permitting them to see 50 ohms at all times. A 50 ohm load on the diplexers is also necessary for good isolation between amplifiers. If one wishes a more versatile unit a directional coupler with its associated switching and metering circuit can be added for monitoring the s.w.r. of the antenna. In our arrangement a switch was added on one amplifier to permit using the amplifier internal metering circuits with an external directional coupler on the antenna.

The relay control lead from the exciter is adapted with a pair of phono plugs to accommodate the relay connections from both linear amplifiers in parallel permitting simultaneous control of amplifier relays from the exciter.

Tune-Up and Testing

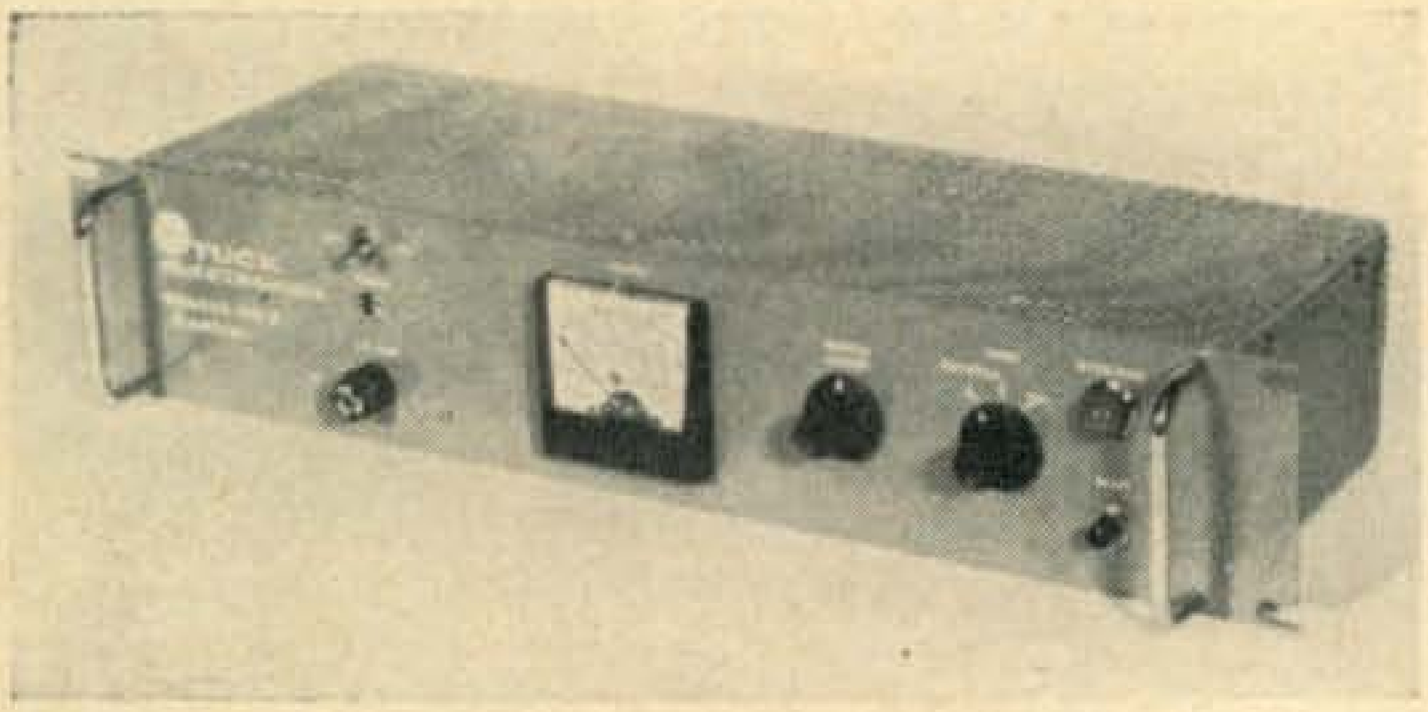
After construction is completed there's a strong urge to throw the switch and make a big

[*Continued on page 104*]

NEW AMATEUR PRODUCTS

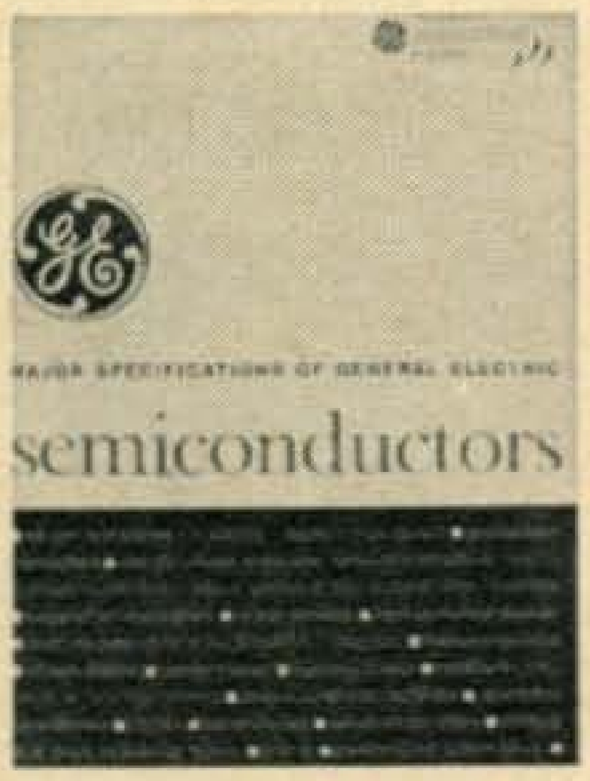
Allied Radio

The fifth edition of the Allied Radio *Electronics Data Handbook* is now available. It covers fundamental mathematical data, electronic formulas, symbols, charts, and interchangeable component tables. The 112 page book contains a wealth of information which is useful in most amateur applications. The price of the book is $.75. For more specific information write to J. W. Rubin, Allied Radio Corp., 100 N. Western Ave., or circle 65 on page 112.



TUCK Electronics

TUCK Electronics, manufacturers of frequency-shift systems, announces a new series of h.f. exciters, based on all solid-state, wideband power amplifier design featuring 2 watts output over a frequency range of below 1 mc to above 30 mc without any tuning. For complete specifications write to B. C. Hill, Jr., TUCK Electronics, 2331 Chestnut Street, Camp Hill, Penna., 17011, or circle 69 on page 112.



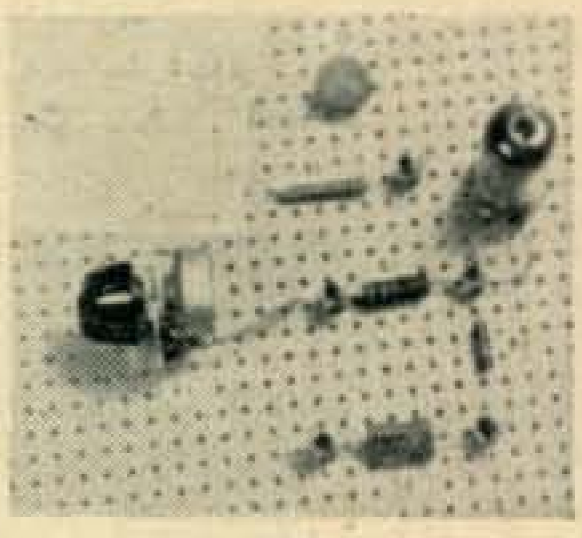
General Electric

General Electric has compiled a new 60 page illustrated catalog (640.12) featuring the major parameters of the G.E. semiconductor line. It also contains about 130 outline drawings and dimensions for the units. For copies of the catalog write to Mr. Gregory Ellis, General Electric, Schenectady, N.Y., 12305, or circle 68 on page 112.

Aladin Kits

The Aladin Kit Co. has recently made available a combination of components and boards to fabricate breadboarding. The first is a solderless terminal assembly (1) which consists of a tightly coiled plated spring slipped over a plated brass stamping. The second is phenolic boards (2) which have 3/32" diameter holes punched on .265" centers. Various sizes are available. The third item is kits of chassis, brackets for switches, pots, etc. For more information write to Aladin Kits Co., 21011 Dequindre Road, Hazel Park, Michigan, or circle 70 on page 112.


(1)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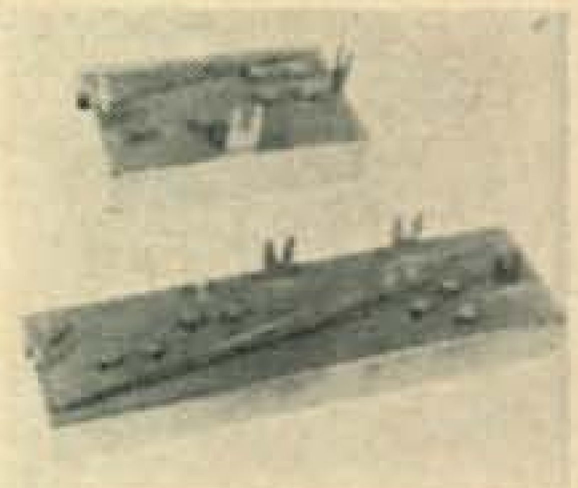
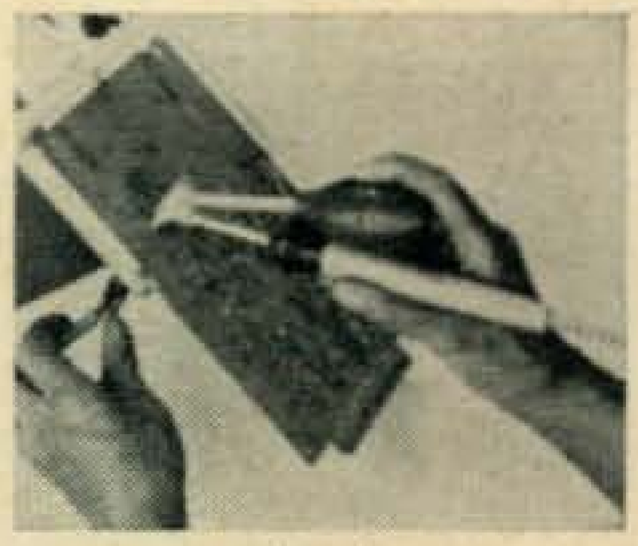

(3)

Amperex

Amperex Electronic Corporation announces the 8643 a new tube designed for mobile application. Due to a new cathode design the tube will function up to 90% of rated power with battery delivery voltage between 10 and 16 volts. It is capable of delivering 135 watts with less than 4 watts of drive up to 175 mc. Further information may be obtained from: Amperex Electronic Corp., Tube Division, Hicksville, L.I., N.Y. 11802, or circling 67 on page 112.

Ungar

Two new soldering aids have been added to the Ungar line of soldering irons. The 6825(top)is a de-soldering tool that threads onto the regular heat cartridge and draws up molten solder with the aid of an aspirator bulb. The 4025 (bottom) is a hot knife delivering approximately 500° to the cutting blade and can be used to cut through epoxy coatings and synthetic materials. For further details write to W. A. Mansfield, Ungar Electric Tools, 2701 W. El Segundo Blvd., Hawthorne, Calif., 90252, or circle 66 on page 112.


(top)

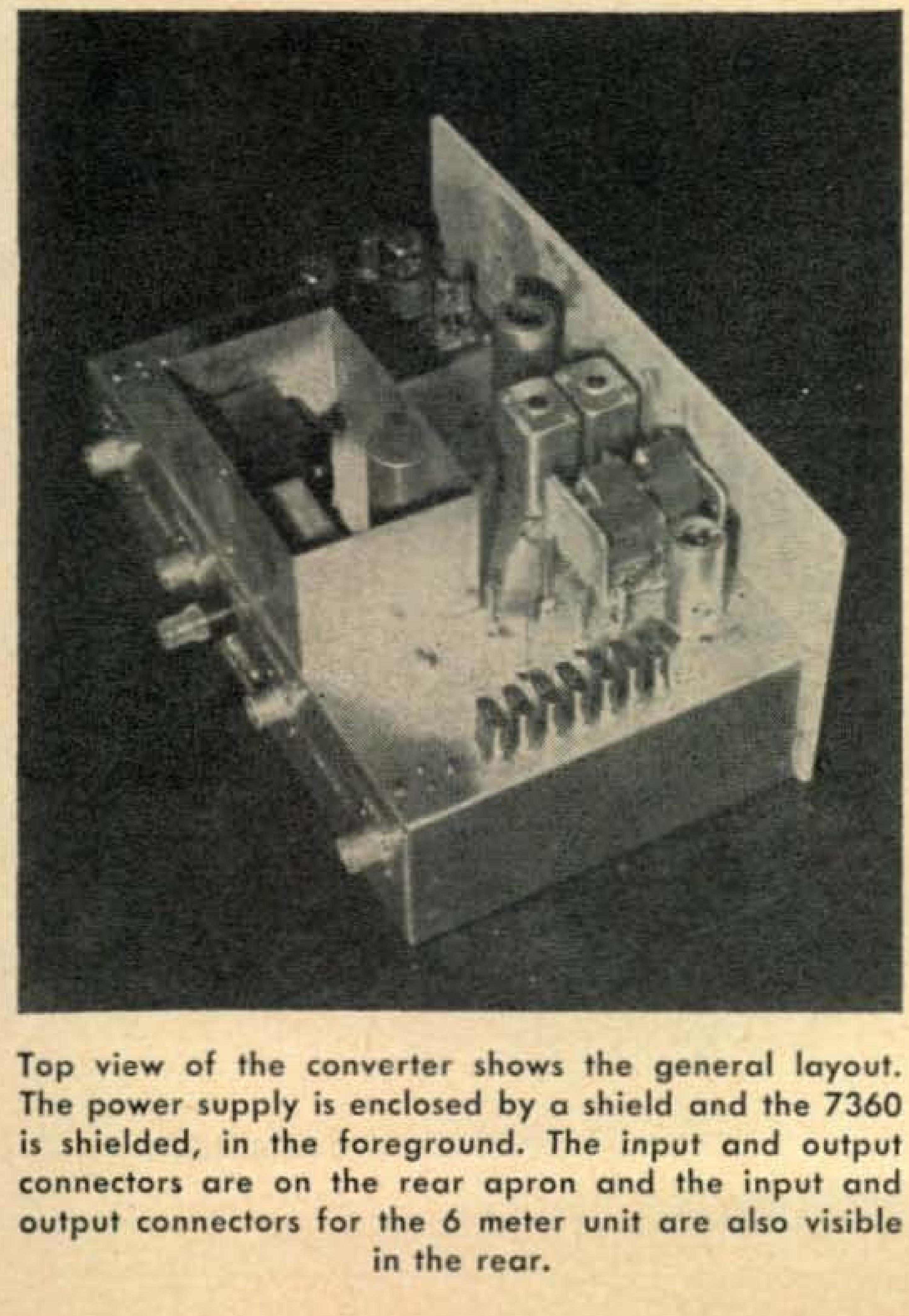

(bottom)

An All-Band 7360 Converter

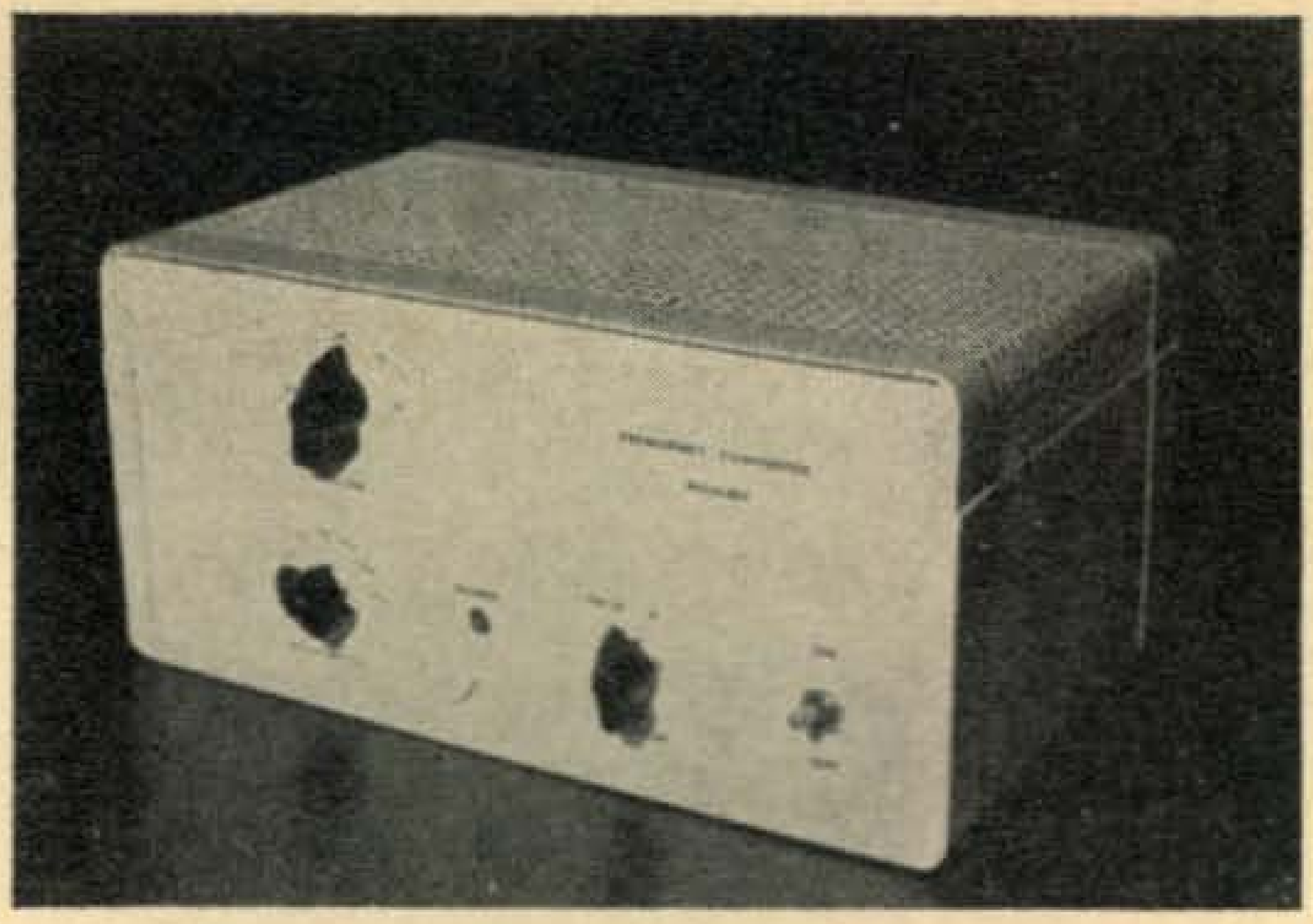
BY CHARLES A. SCHULER,* WA5KBO

While this article does not represent an earthshaking design, it is hoped that it may give a few amateurs some ideas for receiver and converter design. Inspired by an article by W2PUL[1] and occasional openings on 10 and 15 meters, it was decided that a good converter utilizing the 7360 beam deflection tube was needed. Promises of low susceptibility to cross-modulation and good sensitivity with no r.f. amplifier were attractive indeed; so a circuit was constructed.

The circuit shown in fig. 1 is basic and should lend itself well to adaptation for other designs. Seven crystal controlled ranges were included to convert all of the 10, 15, 20, and 40 meter bands into the 80 meter band. This was desirable since an 80 meter receiver of the home-brew variety was in the works at the time. Other amateurs desiring only a portion of the 10 meter band, or those who are interested in only one band, can easily eliminate some of the crystals and their associated tuned circuits thereby tailoring the converter to fit their needs. Also, the converter should work well with i.f. ranges other than from 3.5 to 4.0 megacycles. Of course, L_3 would then have to be tuned to the center of the new i.f. range.



Top view of the converter shows the general layout. The power supply is enclosed by a shield and the 7360 is shielded, in the foreground. The input and output connectors are on the rear apron and the input and output connectors for the 6 meter unit are also visible in the rear.



Front view of the converter. The 6 meter unit that shares the enclosure is on the right and the switch next to the ON-OFF toggle shifts power to either converter.

Components

Some of the components used in this converter were obtained from the junk box. Old television coil forms were rewound and checked with a grid dip meter. However, the parts list contains commercial components that will work well (probably better). Coils L_1 and L_2 were obtained from Burstein Applebee. They are slug-tuned ceramic units in aluminum shield cans and are listed in the sale portion of the 1966 catalog at an attractive price. If these coils are used, the existing windings and components must be removed and the forms rewound using number 24 wire. A grid dip meter is very handy for these endeavors. Commercial coils, such as those specified in the parts list, will work fine.

Construction

Since an existing 6 meter converter was getting kicked around the shack, it was decided that it could share the cabinet and power supply with the new 7360 converter. Separate input and output connectors were provided for this converter and a double-pole double-throw switch selects which converter receives B+ and filament voltages. This is a satisfactory arrangement since both converters are never used at the same time.

The cabinet design represents the combination of perforated aluminum and galvanized steel. This design affords good ventilation and shielding and is not difficult to construct if some basic tools are available. The rounded corners of the cabinet were formed using a wooden dowel rod. The front panel is held to the chassis by the control fasteners and this assembly slips into the cabinet and is secured at the rear with self-tapping metal screws. A two-color paint job and dry transfer letters disguise the "home-brew look."

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*Apartment 11-B Southside, College Station, Texas.

[1] Squires, W. K., "A New Approach to Receiver Front End Design," *QST*, Sept. 1963, p. 31.

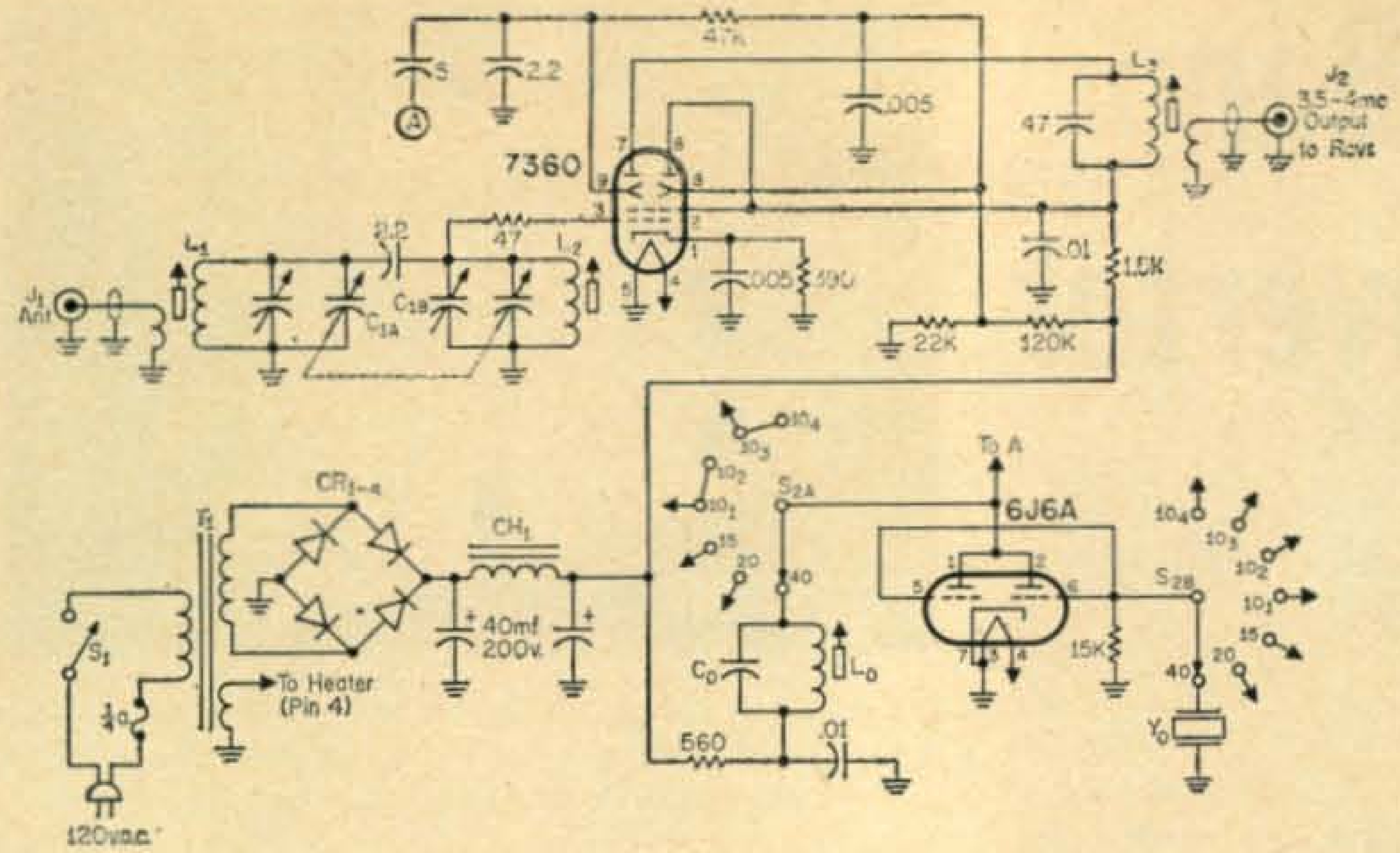


Fig. 1—Circuit of the 7360 Converter that covers 10, 15, 20 and 40 meters. All resistors are ½ watt and all capacitors less than one are in mf, greater than one, in mmf, unless otherwise noted.

C_1—2 gang variable 12—367 mmf per section. Allied Radio 13U521 or equiv.
CH_1—8.5 h at 50 ma Allied-Knight 62U136 or equiv.
CR_1, CR_2, CR_3, CR_4—Silicon diodes, 400 p.i.v. at 750 ma.
L_1—1.2 μh slug tuned coil (Miller 4403 or equiv) with a 3t #24 closewound primary ⅛" from main winding.
L_2—1.2 μh slug tuned coil (Miller 4403 or equiv).
L_3—50 μh slug tuned coil (Miller 4408 or equiv) with a 5t #24 closewound secondary ⅛" from main winding.
S_1—2 pole, 12 pos. ceramic rotary (7 pos. used). Centralab PA-2005 or equiv.
T_1—125 v. at 50 ma, 6.3 v. at 2 amps. Allied-Knight 61U411 or equiv.

Wiring

Building the converter should not pose too great a problem. Due to the absence of a high gain r.f. amplifier, problems with instability are not likely to occur. But good construction practices must be followed just the same. Since the 7360 beam-deflection tube is affected by magnetic fields, the power supply components were surrounded by a galvanized steel shield. Also, the oscillator section was shielded from the mixer under the chassis. These precautions may not be necessary, but it is not worth taking any chances. Adding shields after the converter is completed may prove to be a problem.

Testing

When the wiring has been completed, plug in the tubes and crystals and turn on the power. Check the tubes to make sure that the heaters are lit. If they are not, remove the power cord and check the ¼ ampere fuse. If the fuse is blown, carefully check the wiring for mistakes or shorts.

If everything seems to be functioning properly, the oscillator coils must now be tuned. Connect a receiver that will tune 3.5 to 4.0 megacycles to the converter. Connect an antenna to the converter and adjust all of the oscillator slugs for minimum inductance. Rock C_1 and listen for an increase in noise at one point while slowly increasing the inductance of the oscillator coil being aligned.

If L_1, L_2, and L_3 are too far out of alignment, this method may not work. An alternate method

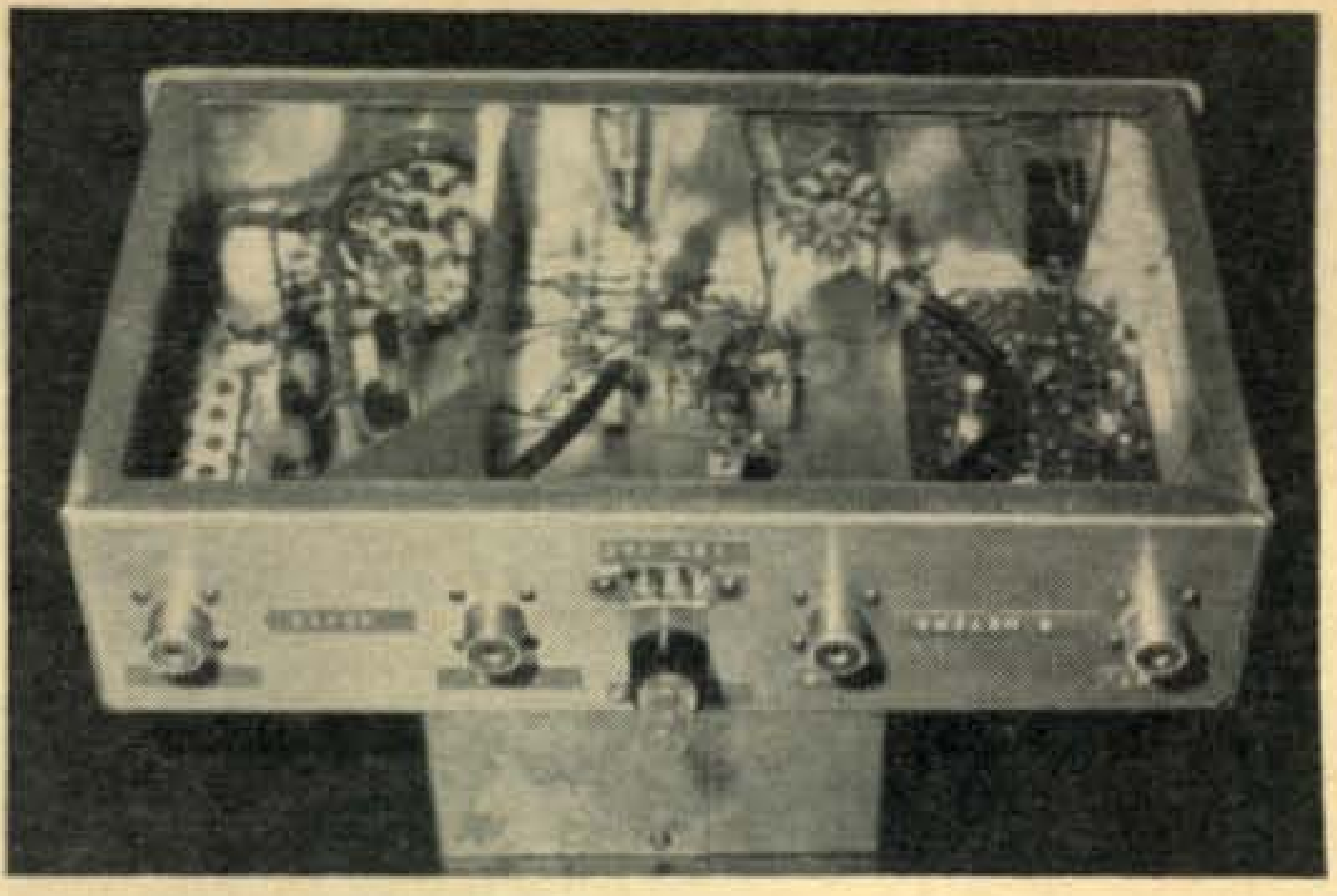
Table I—6J6A Oscillator Component Values

Band		Y_0 mc	C_0 mmf	L_0
40	7.0-7.5	11.0	33	3.1 to 6.8 μh (Miller 4405)
20	14.0-14.5	10.5	33	3.1 to 6.8 μh (Miller 4405)
15	21.0-21.5	17.5	15	1.5 to 3.2 μh (Miller 4404)
10_1	27.0-27.5	24.5	15	1.5 to 3.2 μh (Miller 4404)
10_2	27.5-28.0	25.0		
10_3	28.5-29.0	25.5	15	1.5 to 3.2 μh (Miller 4404)
10_4	29.5-30.0	26.0		

is to loosely couple a general coverage receiver to the oscillator stage while tuning the slugs. This receiver should be tuned around the crystal frequency and will detect a carrier when the oscillator begins to function. A voltmeter check across the 560 ohm resistor in the plate supply line of the 6J6A oscillator stage should show an increase in voltage when an oscillating crystal is removed from its socket. A voltmeter check should show a decrease in voltage across this resistor when a crystal begins to oscillate.

Each oscillator coil must be adjusted so that the oscillator functions on every range. Slight interaction may require the process to be repeated once all of the coils have been adjusted. The four 10 meter crystals share two tank circuits. In adjusting each of these coils, a compromise setting must be found that will give good operation for both crystals. If a vacuum tube voltmeter with an r.f. probe is available, the r.f. potential at pin nine of the 7360 mixer should be about four volts on every oscillator range.

Next, the input circuit must be aligned. A signal generator, the station v.f.o., or on-the-air signals can be used. Set S_2 for the 40 meter band and tune C_1 for maximum capacitance. Set the receiver at 3.5 mc and feed a 7.0 mc signal into the input of the converter. Peak the slugs in L_1 and L_2 by using the receiver's S-meter as an indicator. Now set S_2 for the highest segment of the 10 meter band and set the receiver for 3.7 mc. Tune C_1 for minimum capacitance and feed a 29.7 mc signal into the converter. Peak the signal using the trimmer capacitors on C_1. This alignment step for the input circuit should be repeated until the proper tracking is achieved. Fairly sharp tuning of C_1 should be noticed once the correct alignment has been attained.



Underneath view of the converter. The six meter converter is to the right and the placement of the oscillator-mixer shield can be seen. The unit is resting on the power supply shield.

Inductor L_3 should now be peaked at the center of the i.f. range. This can be accomplished by feeding in a signal on any band that will give an output of 3.75 megacycles. For example, S_2 could be set for the 20 meter band and a 14.25 megacycle signal will give an output frequency of 3.75 megacycles.

On-the-air operation with the converter has proven it to be a worthwhile project. Its sensitivity is good and it appears to be immune to cross modulation. Of course, the mixer in the receiver really should be a 7360 also as cross-modulation can occur there. This is the next project on the agenda. Why don't you try the 7360 in such a circuit? ■

* * *

"Illinois Radio Amateur of the Year"

BY JORDAN KAPLAN,* W9QKE

YOLANDA Weisshappel, WA9CCP, 3122 Clinton Avenue, Berwyn, Illinois, was the recipient of the first "Illinois Radio Amateur of the Year" award sponsored by the Hamfesters Radio Club of Chicago for 1966. The award was presented to her at the 32nd annual Hamfest of the Hamfesters Radio Club on August 14, 1966 in Santa Fe Park, near Chicago, Illinois.

Yolanda is a member of Navy MARS, and is alternate net control of the North Central Phone net. During the past 12 months she handled 13,366 pieces of traffic being the only amateur in Illinois to receive BPL awards for each month of the year.

Yo is active on all bands, and all modes from c.w. and phone to RTTY. Yo and her husband, Karl, WA9CCQ have 4 children, all girls. Handling traffic for servicemen and their families takes a large part of her operating time.

Nominations for the "Illinois Radio Amateur of the Year" for 1967 can be sent to Hamfesters Radio Club, Inc. at 6000 South Tripp Street, Chicago, Illinois 60629. For additional details contact the author.

Yolanda Weisshappel, WA9CCP.

---

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MEDICAL ASPECTS OF RADIATION

BY DR. HAROLD W. MORGAN, M.D.,* K0JTP[1]

There are two types of radiation which can be of concern to amateurs, waveforms with which we deal all of the time and quantum or particular radiation which can occur when waveform radiation of sufficient voltage and frequency is used under certain conditions.

Examination of fig. 1 shows that, for our purposes (the amateur frequencies) the spectrum begins somewhere over 1 megacycle or about 10,000 meters. As we move up the spectrum we arrive at 2 meters. In order to get into quantum energy ranges we have to move into higher frequency ranges or much smaller wavelengths, well below 1 cm. At this point our interest centers on infrared, ultraviolet, Grenz rays and X-rays. (Grenz rays are the longest measureable X-rays.)

Hazards

What dangers does a ham subject himself to in working with radiation? The shock hazard comes first and is well documented and well known. Work in a dry place, keep one hand in your pocket and have the equipment grounded. Electrical currents kill by stopping the heart action and the brain undergoes lasting damage after four minutes without blood, even if life is restored.

Fevers

It has been known for many years that people working in close proximity to radio transmitters of high power will run a fever. This is due to induced eddy currents within the body by the radio frequencies generated by the transmitter.

The wavelengths below 10 meters are known as Hertzian waves, and they extend to the infrared range. These are the ranges used in diathermy, or heat treatments. Besides the generation of heat, they can be used for cutting currents, and are so used in medicine, as they combine the separation of tissue and the control of bleeding by cautery effect at the same time. This is why an r.f. burn is slower to heal than a knife cut; it combines a cut and a burn.

Fever therapy has been used in medicine for a long time, usually on local areas, but before the advent of antibiotics it was sometimes used with a "sleeping bag" insulator to elevate the body temperature and destroy infections. The body maintains its temperature within very narrow limits unless some means of preventing radiation of heat is present, so the risk of a fever from working around ham equipment is very remote. High power transmitters, in close quarters along with heavy clothing worn by the operators might elevate the temperature, but no real danger would be present.

During the last war all diathermy equipment had to be registered with the FCC, and this is still true because in reality such equipment is a radio transmitter coupled to a coil for efficient transfer of the energy to the patient.

X-Ray

Ionizing radiation, x-rays of long wavelength can be generated by means of high energy, high frequency currents. Roentgen produced the first x-rays using a Crooke's tube, a diode without a filament, and if enough energy is used any tube with these elements will produce x-rays. This does happen in TV picture tubes, if enough voltage is applied, or in transmitter rectifiers or multigrid tubes. Voltages in the range of 15-20 kv could produce Grenz rays, but these are of so "soft" a nature that they are absorbed by a few centimeters of air. The lowest range of x-ray

[Continued on page 104]

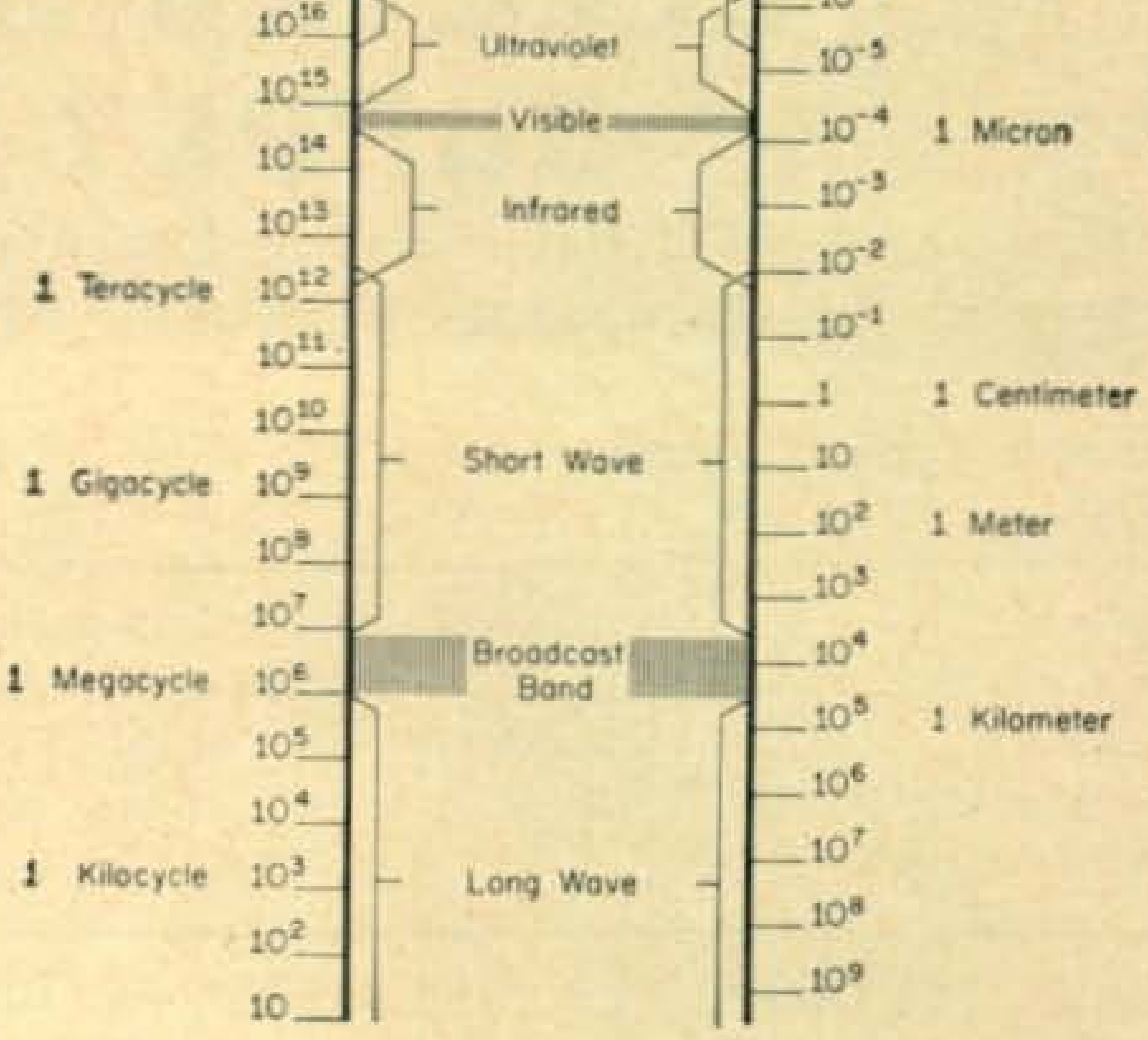

Fig. 1—Chart showing the electromagnetic spectrum in frequency (c.p.s.) and wavelength (cm).

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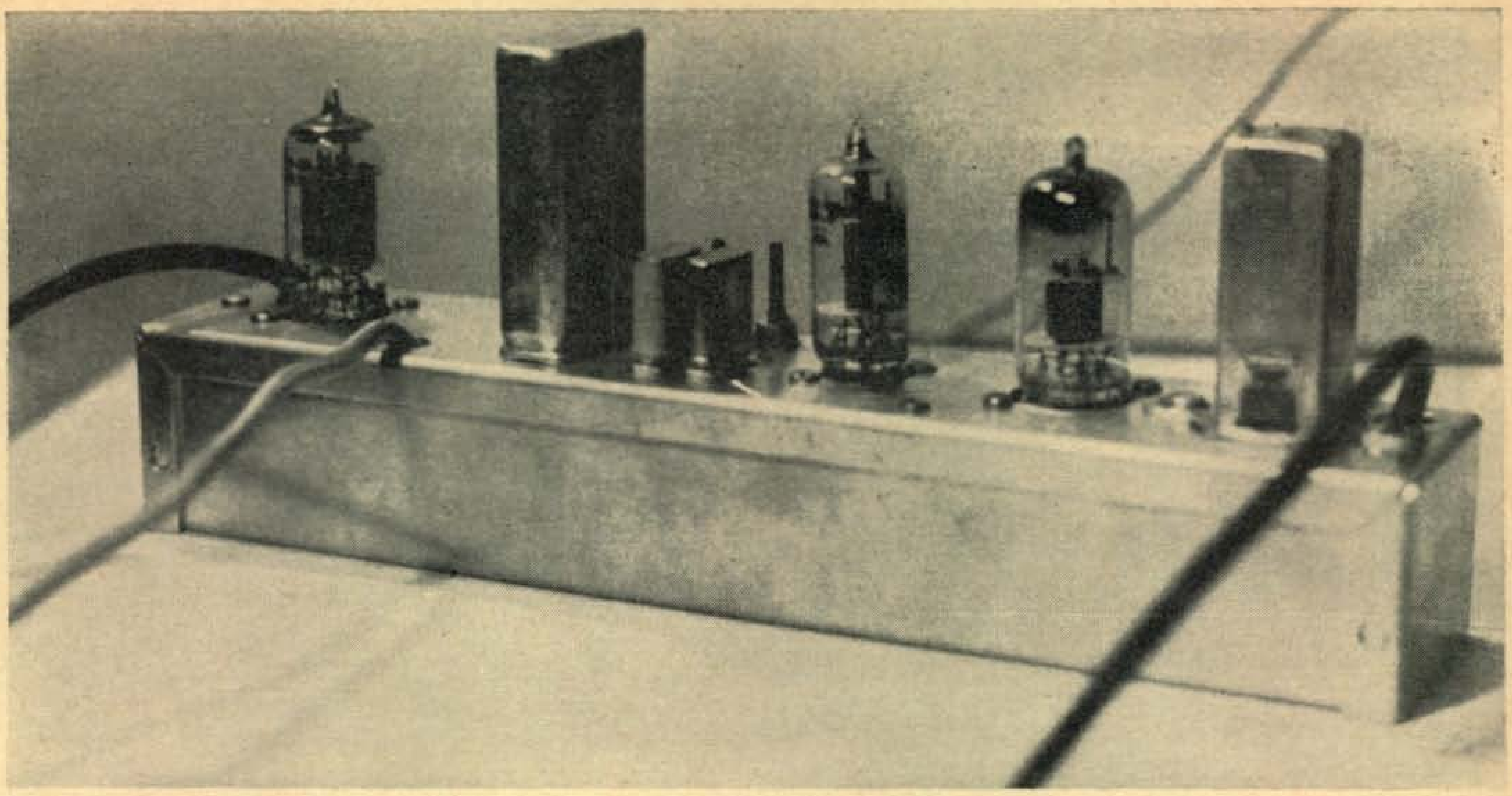
*1312 Fourth S.W., Mason City, Iowa.

[1] Dr. Morgan is a Radiologist.



Product detector for RTTY reception. This is the second model the author made when an unfortunate fire ruined his home and equipment. From l. to r. output cable, audio amp. (12AT7), power cable, relay, crystals, osc. (6AU6), detector (12AT7), i.f. xfmr., and input cable.

RTTY Linearity Improvements

BY C. H. COMBS*

The problem of copying RTTY through interference involves more than just receiver selectivity. The factors involved are harmonic generation, cross-modulation and intermodulation distortion. Covered below are techniques to be used to reduce these faults. Also discussed are the relative benefits of various types of Terminal Units.

LET'S face it, despite improvements, most amateur set-ups to receive f.s.k., while they work relatively well under clear channel conditions, fold up when interference is close enough to the desired signal to come in through the receiver's passband. Fantastic sums have sometimes been spent to reduce the receiver's passband to incredibly narrow widths to avoid this. The result is usually distortion of the signal, particularly if a weak one, and even more difficult tuning than before.

You are set up copying a signal, and everything is fine. Suddenly a powerful c.w. station opens up a kilocycle or so above or below your signal, or perhaps right between the two tones of your signal. Or maybe it's another f.s.k. signal, or a nearby voice station. It doesn't really matter which, because you lose copy. Nothing comes through very clearly, unless the signal you are listening to is many times louder than the interference and stays that way through any and all fades.

"Impossible!" you say, "I have filters in my f.s.k. TU that have 40 db rejection outside their passband, and that's only 100 c.p.s. wide for each tone. The c.w. must be right on top of the station I am listening to to wipe me out like that."

Well, chances are it isn't, at least not all the time. "So," you say, "I'll construct another comb filter ahead of the limiters in my terminal unit and knock that interference out for good."

So, you do, and you get a small improvement, but still the interference bothers you, for you are a victim of *non-linearity*.

It probably exists in your receiving system in several places, and it causes interference to your desired signal that simply didn't exist before it hit your antenna. The interference is generated by three distinct methods:

Multiplication—A signal coming into the receiver so as to make an audio tone lower in frequency than the 2125 and 2975 c.p.s. tones used by audio TU's, will generate harmonics that fall in your filter passbands.

Example: A c.w. station producing 520 c.p.s. out of the receiver gives additional tones in the output of 1040, 1560, 2080, 2600 and 3020. One of these, 2080, drops right on top of the lower

---

*611 Walnut Avenue, Syracuse, New York.

f.s.k. tone as far as the filter is concerned, and 3020 is very close to knocking out the second. Under adverse case conditions, these harmonics may be only a few db weaker than their fundamental, and may easily be louder than the f.s.k.

Cross modulation—The changing of amplitude of the desired signal by the comings and goings of an undesired signal not on the same frequency. In our f.s.k. case, it is generally caused by a.g.c. action, noise limiters, and the limiters in the TU.

Example: A powerful a.m. or c.w. station opens up near your f.s.k. signal, and your f.s.k. signal seems to disappear from sight, or become greatly reduced in amplitude. You find your signal varying in amplitude in response to the keying or voice information on the other station.

Intermodulation distortion—The manufacture of new frequencies by the addition and subtraction of existing frequencies, with the additional frequencies not being harmonically related to the original frequencies. This is the most insidious trouble of all, because it is so little known. It is what you are trying to eliminate from s.s.b. when you go to a product detector. It is what makes s.s.b. signals, received on a.m. sets with b.f.o.'s, sound so distorted. It is the real reason behind the two-tone test used to set up s.s.b. transmitters, although it is almost never used for this purpose out in the field.

Example: Two carriers come on producing audio tones at the output of the receiver of 500 and 900 c.p.s., respectively. These add to produce 1400, subtract and produce 400. The 500 and 1400 add to produce 1900, the 1900 and the 500 again add to produce 2400, the 2400 and the 400 subtract to produce 2000, knocking one of your signal tones out, and so on. Any conceivable sum or difference of the two original tones can interact again and again, so in effect what develops is a huge band of tones clustered around the original ones. Their amplitudes vary widely from one another according to complicated formulas of no great importance here, but they can scramble anything that gets in their path, one way or another. You don't need two other interfering stations either; one station can add and subtract with the tones of your desired signal and do the job just as well. The c.w. station in the example above would generate intermodulation products as well as multiplication products.

The severity with which these effects of nonlinearity may occur vary widely from one installation to another, but are nearly always present. This is why the signal you want to copy must be out in the clear for you to receive it successfully.

By now you are probably thoroughly upset by the spectre of a whole mess of unwanted audio moving in on top of your RTTY reception, so we'll now proceed to stop all that. Commercial multiplex transmissions will place 16 f.s.k. channels right next to each other in frequency and have no cross interference between them. If all the changes I am about to outline are made successfully, the only limit to your ability to copy signals buried in other signals will be your ability to read through the c.w. with your ears and tell that they are there.

There is of course, the consideration of genuine co-channel interference. If there is another station actually on top of or very close to the frequencies of the f.s.k. you are listening to, or if a nearby audio station actually has some of its frequencies covering over your desired signal, then you have problems. This is not the fault of your equipment, and attempting to phase out the interference with directional antennas is about your only hope.

Modifications

First we will take up the receiver, as, despite feelings to the contrary, most practical f.s.k. reception shortcomings are apt to be found here rather than in the TU.

Note this carefully: if your receiver is actually intended for s.s.b. reception, and actually has a genuine product detector built into it, (any other kind of detector or "exalted b.f.o." arrangements do not count), then your receiver is probably good enough to receive f.s.k. adequately. The Collins 75S type receivers and the Drake 2 type receivers are examples of sets that will do the job without modification.

However, all receivers without product detectors will need this kind of modification even if they are customarily used for s.s.b. reception. The Collins 51J4, the Hammarlund SP600, and the military R390 or R390A, (there is a large difference between these two versions by the way), are examples of receivers commonly believed to be adequate for s.s.b. reception and f.s.k. reception but when used as is, actually produce much too much intermodulation for either mode. Then of course there are all the older or less expensive sets that fall into the Hammarlund HQ120 class. These sets are actually very close to shortwave broadcast receivers with the addition of a better i.f. strip and a basic crystal filter. *Do not overlook these sets;* many of them will work excellently if you can stand the poor tuning ratio and the lack of resetability.

One check should be made on your receiver: it should be stable enough as to drift, or be capable of being modified for such stability, or it isn't worth improving the linearity. I would say that with steady line voltage and the set thoroughly warmed up, it should stay on an f.s.k. signal at least fifteen minutes to be usable in amateur service. Don't overlook the possibility of adding plate and filament voltage regulator circuits to the oscillator, and of course, never turn the set off; that just invites drift.

Procedures

Eliminate audio images—Audio images make it possible to tune in a signal several kilocycles away from the desired signal, (usually no closer), and have it superimposed on the desired signal. To do this, remove the b.f.o. from the

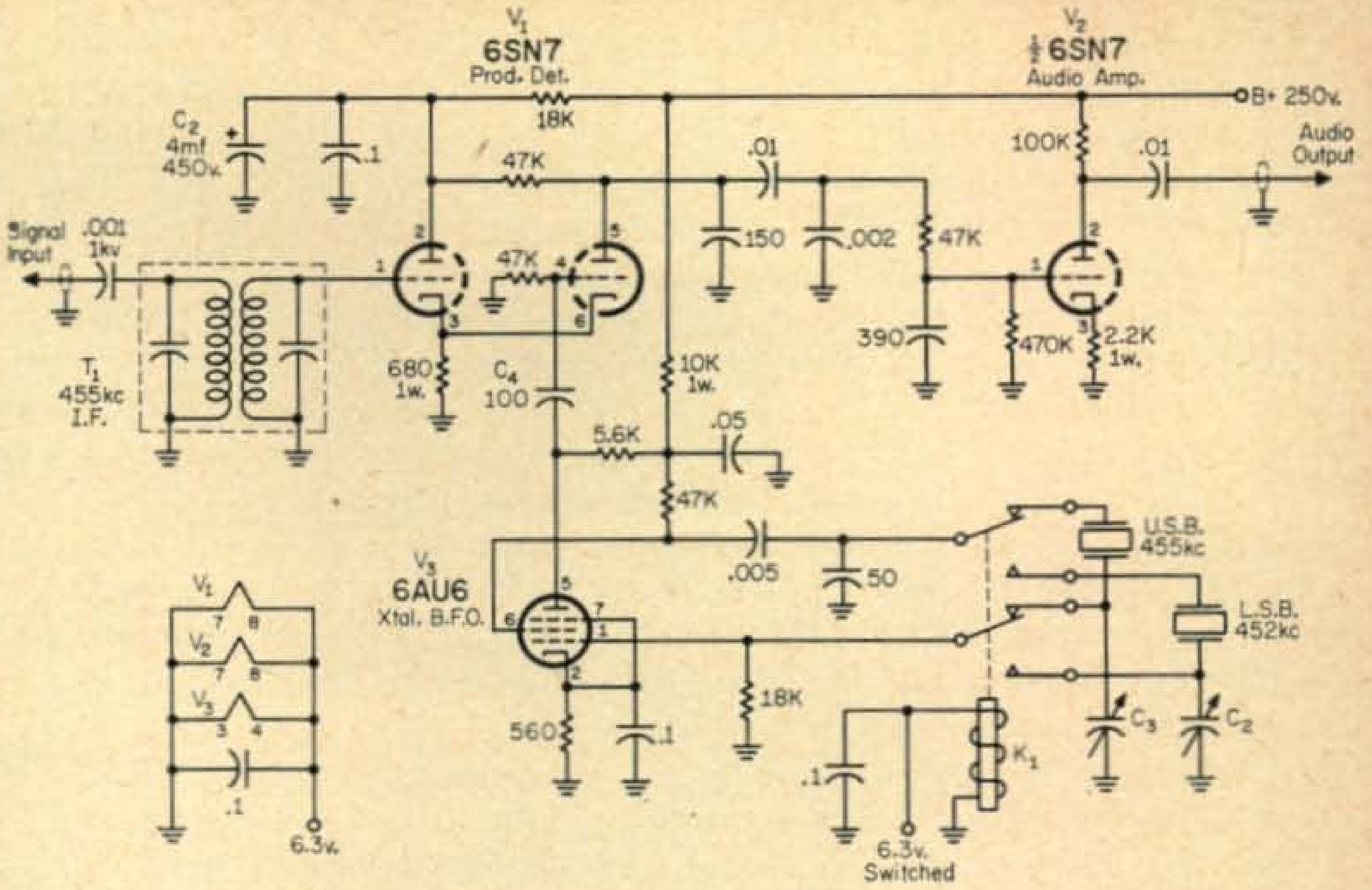


Fig. 1—Circuit of a product detector to adapt amateur receivers for reduced intermodulation distortion in RTTY copying. Capacitor C_1 value is nominal and should be adjusted as described in the text. Capacitors C_2 and C_3 are 1.5 to 25 mmf piston trimmers used only if a crystal or mechanical filter is part of the receiver. If not needed, 15 mmf micas can be used. The i.f. transformer is a Miller K-Tran #12C2 (455 kc) or equivalent; the relay is a d.p.d.t. with a 6 v.a.c. coil, Advance AM/2C/6VA or equivalent. All resistors are ½ watt unless otherwise noted. All capacitor values less than one are in mf and greater than one mmf except electrolytics indicated by polarity markings; these are in mf. All capacitors should be disc ceramics except for those marked as micas and electrolytics.

passband of the set. If your i.f. centers around 455 kc, don't have the b.f.o. frequency center there too. Put it at 452 kc for example. In this way the signal appears only once as the set is tuned by it. The tones come in high, go down to zero, and then don't rise up again. Thus audio images are avoided. An adjustment to the b.f.o. coil, or can, will effect this change.

Turn off the a.v.c., or a.g.c.—Use wire cutters if necessary. Never use any form of automatic volume control with f.s.k. The best it can do is nothing. The worst is plenty. A.v.c. doesn't care what kind of signal comes in your set, it has instructions to let only so much come in, then drop the gain, usually drastically. It doesn't mind a bit if a signal 9 times louder than the desired one finds its way in alongside the desired one. It cheerfully drops the gain and the desired signal gets 9 times fainter than it was before.

Reduce the r.f. gain—This is a matter of operating procedure. It is suggested to reduce cross modulation in the i.f. strip of the receiver and as a compensation for the removal of the a.v.c. Keep the r.f. gain as low as possible, and raise the audio gain. This will narrow the passband too, often quite a bit, if it is an inexpensive receiver.

Install a product detector—This one step will do much more than any other as far as the receiver is concerned. It is the master step that makes yesterday's a.m. set, with its fuzzy rendition of complex signals, into today's set with its crystal clarity definition between close spaced frequencies. Its importance cannot be emphasized enough. Basically, most non linearity in any receiver occurs in its a.m. diode detector, exalted BFO's and other gimmicks not withstanding. At least 35 db down from the signal on all distortion products is wanted here, and the best the diode detector can usually do is 15. This is disastrous. A signal that at any time gets a mere 10 db or so louder than the desired signal can wipe you out, even though it may be a clean 2 kc away.

Because it requires a quieter power supply source and much higher audio gain than exists in an a.m. set, it is recommended that the product detector be built as an outrigger on its own little chassis, and perhaps installed in the receiver above the chassis. Don't build it into the chassis unless there is plenty of room there; you'll need it.

A good workable line-up is suggested in fig. 1. This configuration is used because it avoids, completely, all tapped coils, push-pull signal requirements and tricky balancing adjustments that make a nightmare out of so many product detector units. It has been very successfully added to a number of sets, as well as being used in original constructions from scratch. A crystal b.f.o. unit is shown along with the detector, and this is a great convenience. The two crystals generate frequencies at the edges of a supposed 3 kc wide passband of the set's i.f. strip. This is for standard s.s.b. reception, and eliminates the ambiguity of where to put the b.f.o. In one position, u.s.b. stations will tune in perfectly, in the other, l.s.b. stations fit right in. No trouble, f.s.k. signals are positioned near one edge of the passband, but this edge can be reversed by switching the crystals, giving an opportunity to cut off one strong adjacent channel station. A front panel switch marked LSB-USB is added in place of the old variable b.f.o. knob. The relay circuit for crystal switching allows the b.f.o. to be any convenient distance from the front panel without lead capacity trouble.

This advanced form of b.f.o. doesn't have to be used however; the circuit will accept the output of the original b.f.o. very nicely.

A stage of audio amplification is included in the adapter because the output of the product detector will be considerably lower than that of the original diode detector. Do not skimp on the heavy B plus filtering shown. The product detector as well as the low level audio amplifier are sensitive to hum, and this filtering is needed to get a quiet circuit.

The completed unit can be connected into the receiver with a switching arrangement so that the original diode detector can be used for reception of a.m. If a.m. is no longer actually used in the station however, the diode detector can be eliminated.

A high impedance connection to the receiver's i.f. strip is used for simplicity. This works very well if the coaxial cable is kept down to a few inches in length and the receiver i.f. can is retuned. A general physical layout of the little chassis is offered, but the exact size and shape will depend on the receiver in question.

The only critical adjustment is the amount of b.f.o. injection, which is controlled by C4. Start with the suggested value, and when the receiver is working, try changing it. Increase the value up to the point where further increases do not bring any further increase in output volume. Then decrease it until the volume has fallen off a bit. Maximum volume out of a product detector is seldom reached at the point of minimum distortion, and this rule of thumb will insure reasonable performance.

Re-engineer the receiver audio system for lower distortion—The audio amplifiers in all too many receivers are designed with maximum gain in mind, and settle for a 10 percent distortion figure which is murderous for f.s.k. or s.s.b. reception. The R390 is known to have an adequate audio system, but other receivers may need changes. Generally it will be a two stage device. For low distortion, the first stage should be a triode, not a pentode, and changes that will help, include removing all cathode bypass capacitors, lowering the value of plate load resistors, and adding a negative feedback loop from the output transformer back to the first stage. In other words, follow regular hi-fi practice, and you can't miss. The copying of a small hi-fi amplifier final stages into the receiver is an excellent suggestion if there are any doubts. The final output volume may be a bit lower, but most receivers have far more than is needed anyway.

This completes an outline of the modifications that will make the receiver adequate for good f.s.k. reception. A final bit of sophistication that really pays off would be the insertion of a mechanical filter or a crystal filter, either manufactured or home made, in the i.f. strip. It should be 3 kc wide, and the crystals used in the b.f.o. tailored to just hit the edges of its passband. The crystal filters suggested in books on building s.s.b. transmitters are excellent for this purpose. I am not talking here about the old single crystal and phasing control type of unit. This does little good in this application.

Note that if the filter used has a rounded top on its passband, it will be necessary to place the b.f.o. frequencies further outside its passband to allow the tones to be in the middle of the bandwidth. This adjustment will not work for receiving s.s.b. which requires crystals at the passband edges. This is true of inexpensive filters like the Lafayette mechanical filter. The alternative is to use audio filters in the TU much lower in frequency than standard. For 850 shift, 1275 c.p.s. and 2125 c.p.s. will work.

The filter should be substituted for the first or second i.f. can in the i.f. strip, and may in some cases require the addition of a stage of amplification.

If this filter is added, and the other changes made as outlined you will have a receiver that will perform as well as $1,000 units, as far as the quality of signal you get out of it goes.

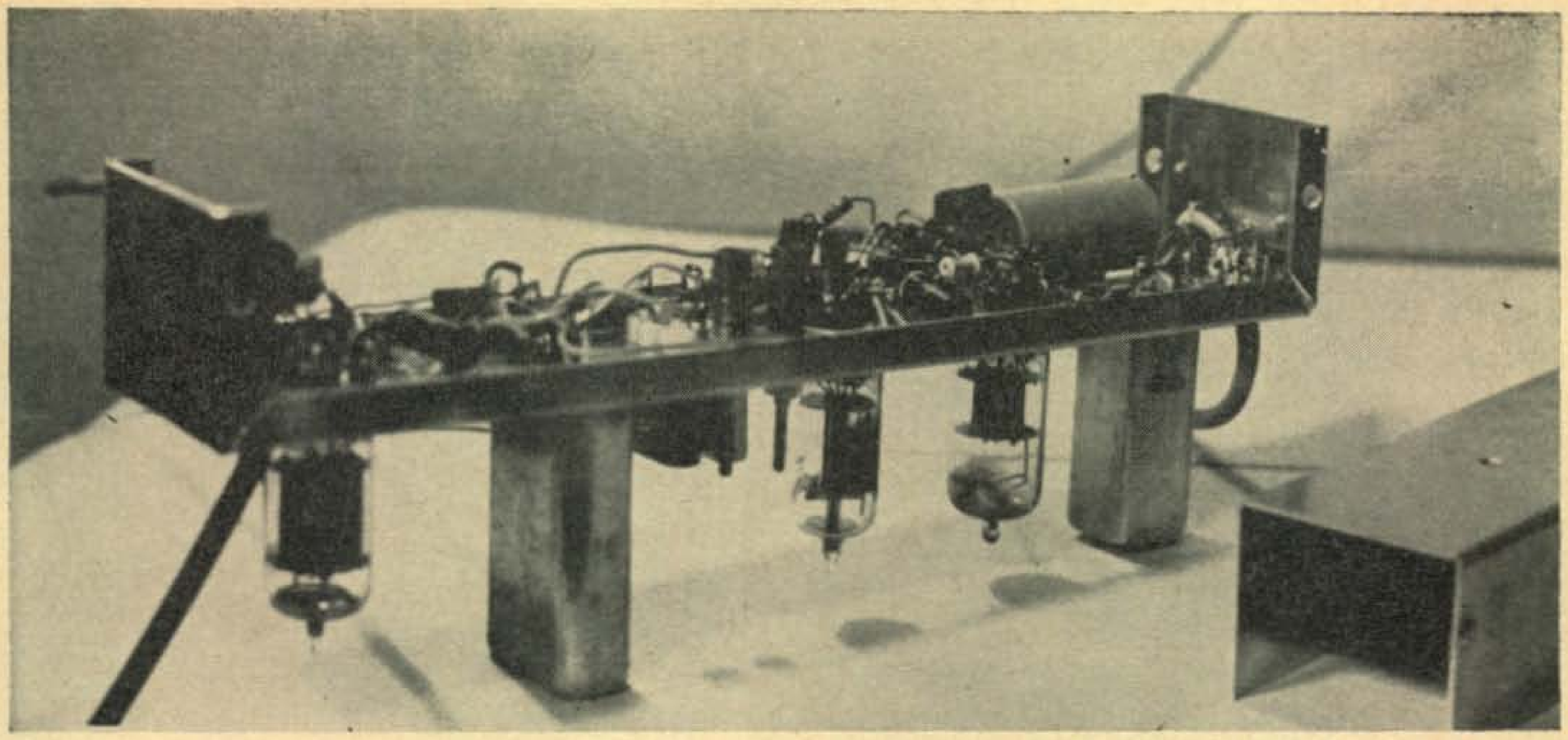
The Terminal Unit

We now move over to the f.s.k. terminal unit. Here our job will be easier. Basically, the limiters must be removed from any TU used in this system. Their operation is similar to noise limiters and a.v.c. action in the receiver as far as generating distortion goes, and if left in will surely cancel out the bulk of the improvement gained in rebuilding the receiver.

First, it is a good time to discuss what kind of TU to use for the very best results.

There are quite a few f.m. i.f. type of TU's around. These do not use audio, but operate as an extension of the receiver's i.f. strip and do their discrimination on the i.f. frequency directly. Most of them are government surplus, with the CV57 figuring prominently among them. This type of TU is capable of quite good results, but falls down badly when the channel is not clear, or when the signal-to-noise ratio is poor. The reason is simple. There are no filters in this kind of unit; it views a whole kilocycle of spectrum at all times, with the 850 c.p.s. shift tones in the kilocycle. Any other stations that come on in between the tones of the desired signal, or near it, will get into the TU discriminator full strength and interfere with the reception. This one basic fact makes this type of TU undesirable, and it is definitely not recommended for amateur service.

Why, then, you will ask, was it used almost exclusively by the government? The reason is that the military had a different philosophy regarding radio. They controlled things like transmitter power and channel spacing to a high degree, and they could get the clear channel signals needed. Their aim was not so much to have the equipment work the best way, but rather that it should always work under adverse field conditions. The f.m. TU has the big advantage that it makes possible an easy method of automatic frequency control to counteract the drifting of receivers and transmitters, which was more important to the military than best performance on weak signals. All military f.m. TU's have this feature, and it was needed with the many unstable receivers used 15 to 20 years ago. Another thing that impressed the military was the fact that the f.m. TU will work on any shift, from



An inside view of the product detector showing some of the construction details. Fig. 1 is the same for this version except for the change in tubes.

about 1 kc down to 40 or 50 cycles. This they liked, because they were concerned with equipment mismatches and wanted everything interchangeable. But in accepting this, they gave up high performance, and the f.m. TU today gives a mediocre account of itself, leading to easy discouragement with RTTY. There is also a military audio TU, which looks like the CV57 and is called the CV89. This sounds like a good deal, but watch out; it isn't the type of audio TU familiar to the amateur. It too is a wide-banded discriminator device, and has, in a slightly lesser degree, all the shortcomings of the f.m. type. It is another device made to work on all shifts to some extent and on no particular shift really well. The amateur would do well to avoid this and other military units. They are usually old and tired, are constantly threatened with overheating, and use far too many tubes for the job they do, thus drastically reducing their reliability. The amateur is further warned against using frequency control of the type inherent in these units. It works well on clear signals, but it is all too easy for it to be "captured" by an interfering signal and tear your receiver right off the desired signal. It also causes *mark* hold problems if not adjusted exactly. Automatic frequency control is no substitute for stability.

So for high performance, we are left with the audio TU with filters set for the shift being used.

There must be no limiters before the filters. Linear Class A hi-fi circuits must prevail. After the filters, there can be limiters, clippers, Schmitt triggers galore, but nothing before. This can put the filters close to the first thing in the TU line up. After the limiters have been cut out, there will probably be too much audio gain in the TU, so some of the audio stages can go too, perhaps leaving one between the input transformer and the filters. The input transformer must be a good match for the receiver. If the receiver has a 500 ohm output, then the TU must offer a 500 ohm input. You wouldn't mismatch the speaker of a hi-fi set to the amplifier, so for the same reasons, don't mismatch here. An output transformer with the same impedances as the one in the receiver makes a good input transformer for the TU. But, load down the secondary with its own impedance in a resistor. Just coupling to the grid will reflect a very hi Z back to the receiver and raise your distortion level. Example: 3 ohm output on receiver goes to 3 ohm input winding in TU. The 5K winding goes to first audio tube grid, *with* a 5K resistor across it. Don't worry about gain, you'll have plenty. If there is a comb filter in the TU leave it in, but don't count on it to isolate any limiters from the receiver. It won't do the job that well.

This completes the linearity modification.

Testing

Now we will see exactly how well your system is working, before a f.s.k. signal is copied. This test is for distortion, and assumes that the receiver and TU are, generally speaking, back in working order.

1. Get the equipment set up, and the receiver warmed up to its most stable condition.

2. Tune up to a steady carrier or supply one from a signal generator or your transmitter v.f.o. Work at signal input frequency, use the whole receiver; don't use an i.f. frequency as it won't test out the whole system. Tune this one tone so that it is centered in one of the channel filters in the TU. Keep the receiver's r.f. gain low.

3. Adjust the receiver volume while reading what happens at the TU filter with a scope or a v.t.v.m. Keep on raising the gain until further increases of the receiver's audio control do not result in any further increases at the filter. Now something is limiting, probably the audio stage in the TU. Never operate nearly this high in actual service; always keep the receiver gain way below this. If it now must be set too low to hear comfortably in the headphones, you will have to decrease the audio gain in the TU, but this is rare. Note the setting of the receiver's volume control and the loudness of the sound. If the TU has a level indicator, adjust it to read normal

when you are considerably below the limiting point. Now the level is set correctly.

4. For the two-tone test for intermodulation distortion, it will be necessary to feed two carriers into the receiver now, of about the same level and situated only a few hundred cycles apart. Exact values are not important, as long as you don't overload the receiver in any way. This last is vital; the test signals must be received no stronger than a typical radio signal. One can be your transmitter v.f.o. and the other your signal generator. A steady carrier on the air plus your v.f.o. might be used.

5. When this is set up, connect a scope (vastly preferred) or a v.t.v.m. to one of the audio channel filters in the TU to observe the level of signal there.

6. Now, with the test carriers on, tune the receiver slowly, making sure it is set to give the level of audio output agreed upon in step 3 above. Tune so that the two tones appear at zero audio frequency and start to rise up. First one will appear inside the pass band, and rise up in audio frequency, then the other will follow as you tune across them. Watch the scope closely. When you have tuned so that the highest carrier reaches the filter frequency of 2125 c.p.s. or if on the higher one, 2975 c.p.s., you will see a strong indication on the scope as the audio goes through the filter. Then as you tune further in the same direction, that tone will move up and out of the filter, and then the lower one will appear in the filter, looking the same as the first one. Finally the two tones will move up out of the receivers pass band and you will not hear them any longer.

Now, if everything is right, that is all you will see on the scope. There will be no extra responses or tones seen on the scope as you tune the two-tone test through the receiver's pass band, either while the tones are above or below the filter. Of course, if you turn up the scope gain high enough, you will be able to see other tones, but they should be much, much fainter than the two intended tones from the test carriers. Ideally they would be 35 db fainter, and if a means of accurately measuring this is at hand, do it.

If, on the other hand, you see a range of tones, or a whole band of frequencies as you tune across the test, you still have distortion. Try reducing the r.f. gain and increasing the audio gain. If the distortion persists, something is wrong.

Perhaps the filter can be moved back along the signal path through the various audio amplifiers to check at different points. A long lead connected to its input, using very high impedance might make this possible.

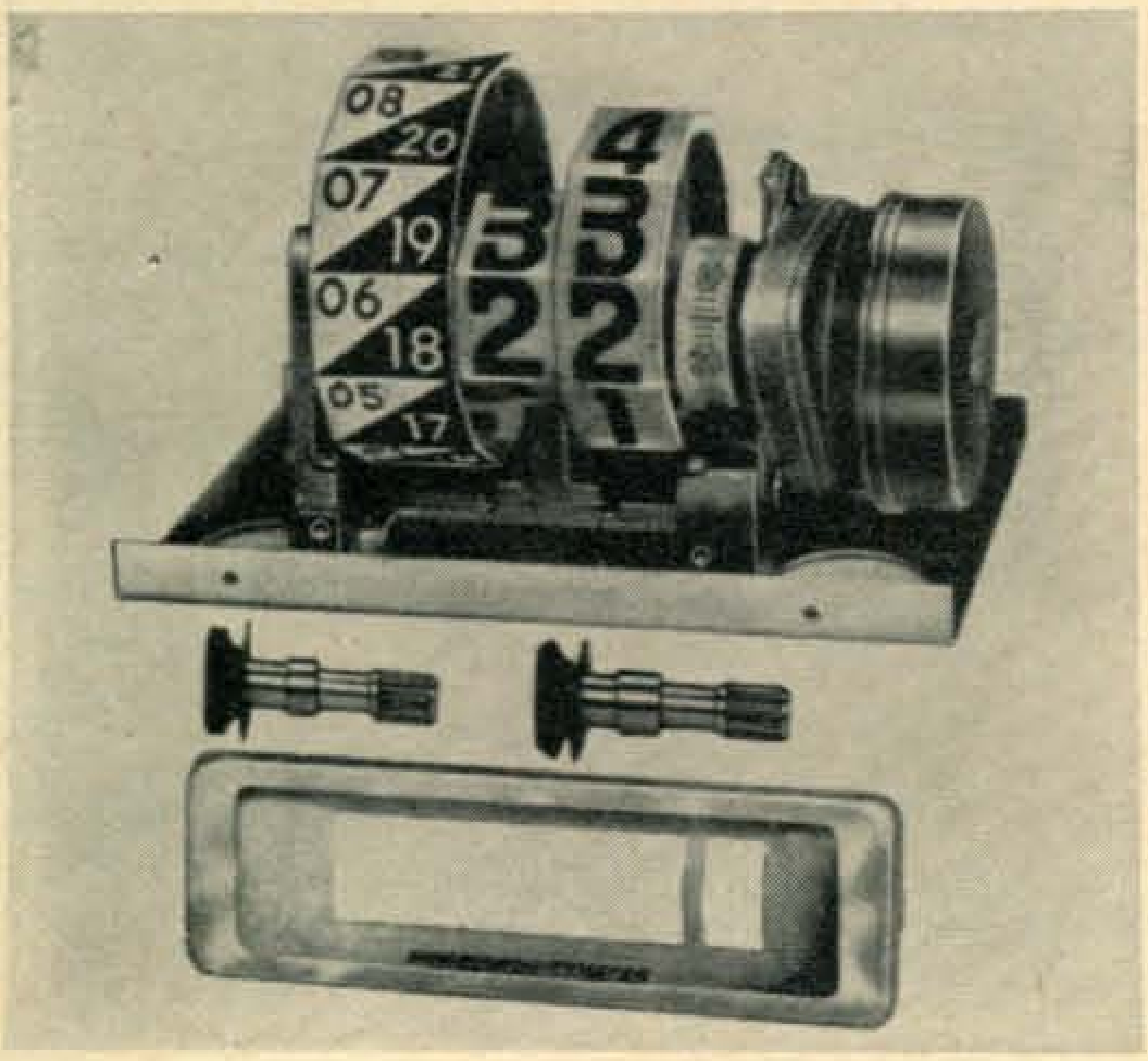
What you just did was to turn your TU filter and scope into a distortion analyzer of the type used to check out the very finest government equipment.

If this test is passed, all is well, and it is time to make copy.

You will find now that you can copy signals so surrounded with interference that it would have been hopeless to try before.

More accurate control of volume is needed now, so that the faintest level of the signal during a fade is still high enough to run the TU, but a little experimentation will show what to do. Experience has shown that volume level is not much of a problem, if the lowest level, right at background noise level is set to run the TU. Then the extreme heights of signal strength that might be achieved above this if it is fading deeply, will probably overload the TU. However, by then the signal will be much stronger than any interference, as the "dynamic range" of this setup can approach 30 db of level change without getting too weak or overloading. ■

New Amateur Product



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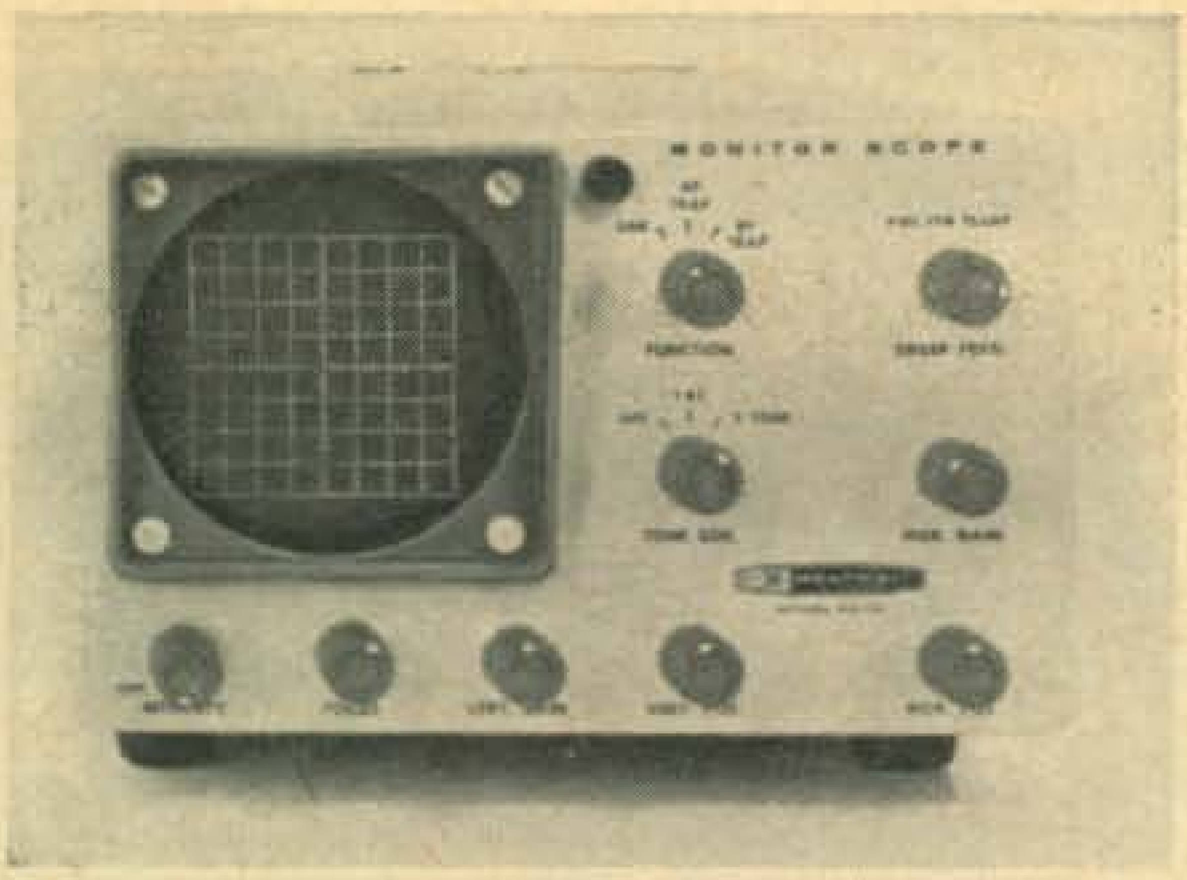


The Oscilloscope

Part IV

BY WILFRED M. SCHERER,* W2AEF

The fourth and final installment of this series explains the use of the scope in obtaining s.s.b., RTTY, c.w. and receiver displays.

OBTAINING and interpreting various displays on the oscilloscope with a.m. transmitters was covered last month. In closing this series of articles concerning the operation and applications of the oscilloscope, we shall consider its use with other modes of operation.

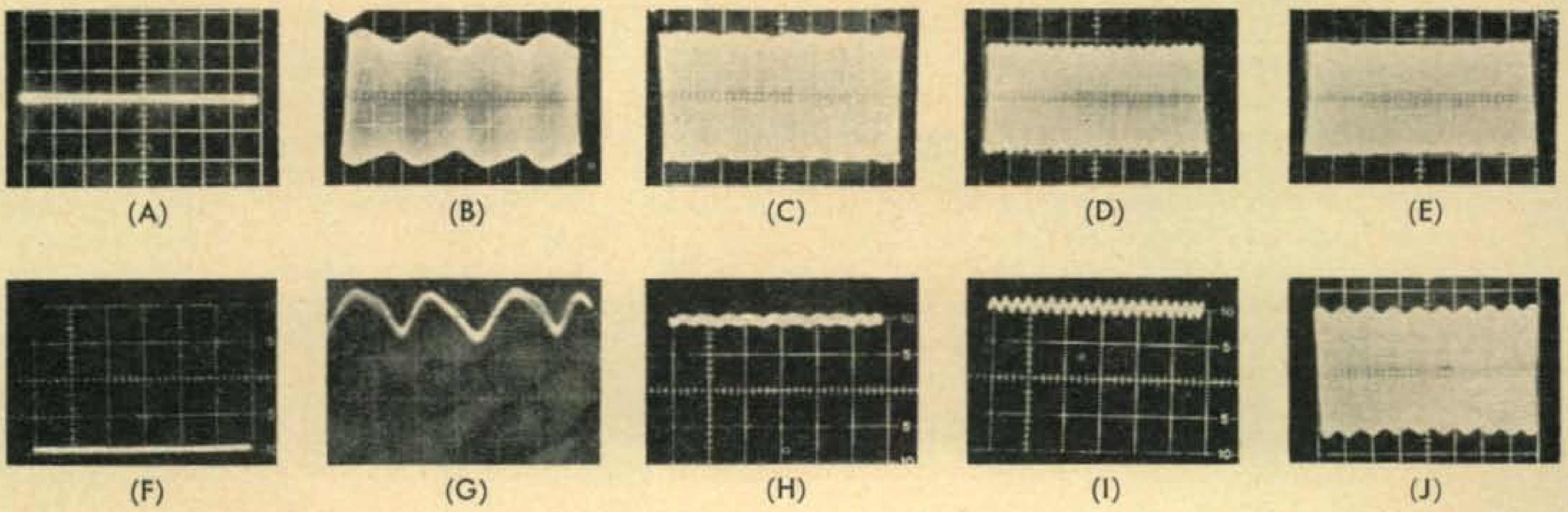
S.S.B. Envelope Displays

R.f. envelope displays with s.s.b. transmitters are obtained in the same manner as are those previously described for a.m.[1]

With the transmitter turned on and its carrier balanced out, only the center reference line will be seen on the c.r.t. If this line is appreciably heavier than it is with the transmitter off, indications are that the carrier is not sufficiently balanced out. (Another cause may be hum or noise.) With a steady a.f. tone applied to the transmitter input, an r.f. envelope will expand above and below center and a slight ripple may appear across the top and bottom of the pattern. See fig. 1. The amplitude of the ripple, in relation to the overall envelope amplitude, is indicative of the degree of unwanted-sideband suppression *at the particular modulating frequency*. It may be determined as indicated at fig. 2.

Sync should be used to stabilize the horizontal-sweep frequency of the scope,[2] in order that individual ripple peaks may be seen standing still; otherwise they may appear displaced and superimposed on one another, or they may weave back and forth, making a true interpretation of the ripple content and character difficult.

The larger the vertical amplitude of the display, the easier it will be to best determine the sideband suppression, particularly when the suppression is very high in which case the ripple amplitude is very small. Under these circumstances a closer measurement can be made by setting the no-signal reference near the bottom of the c.r.t. face and using only the upper half of the display which can then be made twice as high as before. For a given accuracy, about 6 db greater suppression can thus be determined. In any case, the ripple amplitude becomes so small


(A) (B) (C) (D) (E)

(F) (G) (H) (I) (J)

Fig. 1—At top—s.s.b. r.f. envelope displays. At bottom—demodulated single-line displays. (A)—insufficient carrier suppression fattens the center reference line when the transmitter is turned on. (B)—about 20 db sideband suppression shown with 400 c.p.s. test tone. Note distorted waveform. (C)—about 35 db suppression with 1000 c.p.s. (D)—near 30 db suppression with 2000 c.p.s. Unequal ripple amplitudes will occur when the carrier is not properly balanced with a phasing exciter. (E)—about 40 db suppression at 1000 c.p.s. with a filter exciter. (F)—initial base-line reference for demodulated display. Insufficient carrier suppression will cause the reference to move upward. (G), (H), and (I)—the same signals as (B), (C), and (D) respectively. Traces are fatter than usual due to hum on the carrier. (J)—insufficient carrier suppression with signal at (E) produces high ripple amplitude.

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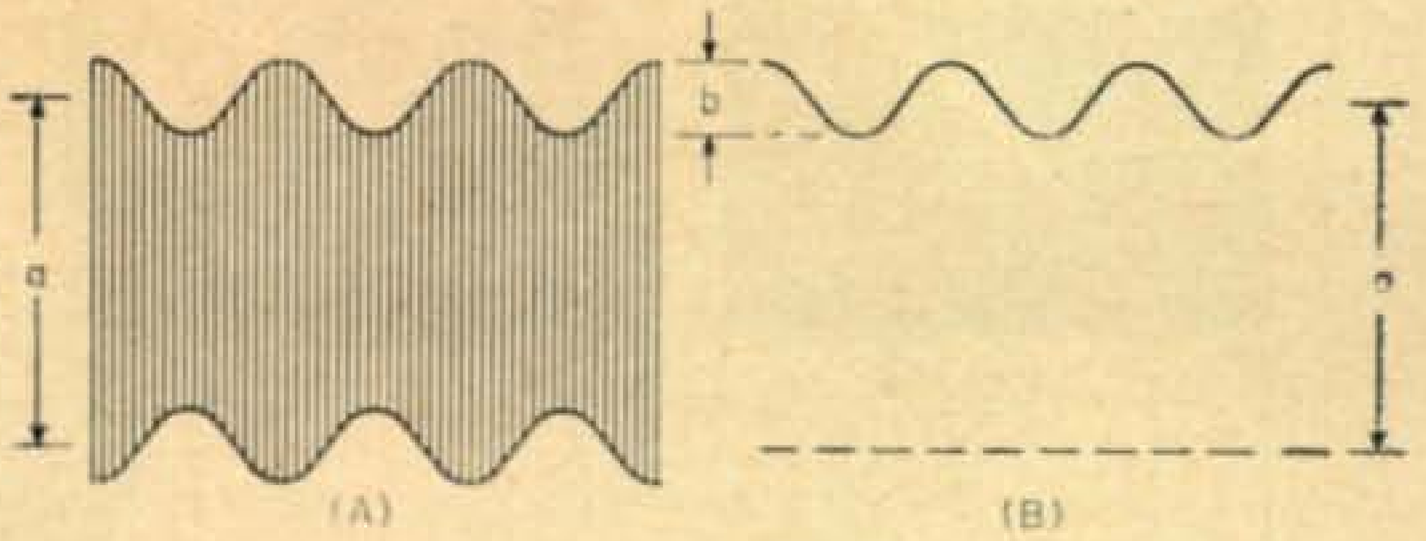
*Technical Director, *CQ*.

[1] The Oscilloscope, *CQ*, Sept. 1966, page 58.

[2] See fig. 4, page 60, *CQ*, Sept. 1966.



Suppression (db) = $20 \log \frac{a}{b}$ Suppression (db) = $20 \log \frac{2a}{b}$

a:b Ratio	Suppression	a:b Ratio	Suppression
10:1	20 db	30:1	30db
15:1	24 db	50:1	34db
20:1	26 db	100:1	40db

Fig. 2—Method of determining unwanted-sideband suppression, (A) — with full-envelope display; (B) — with demodulated single-line display. Also used with displays of only half the r.f. envelope as explained in text. The dashed line indicates the initial reference.

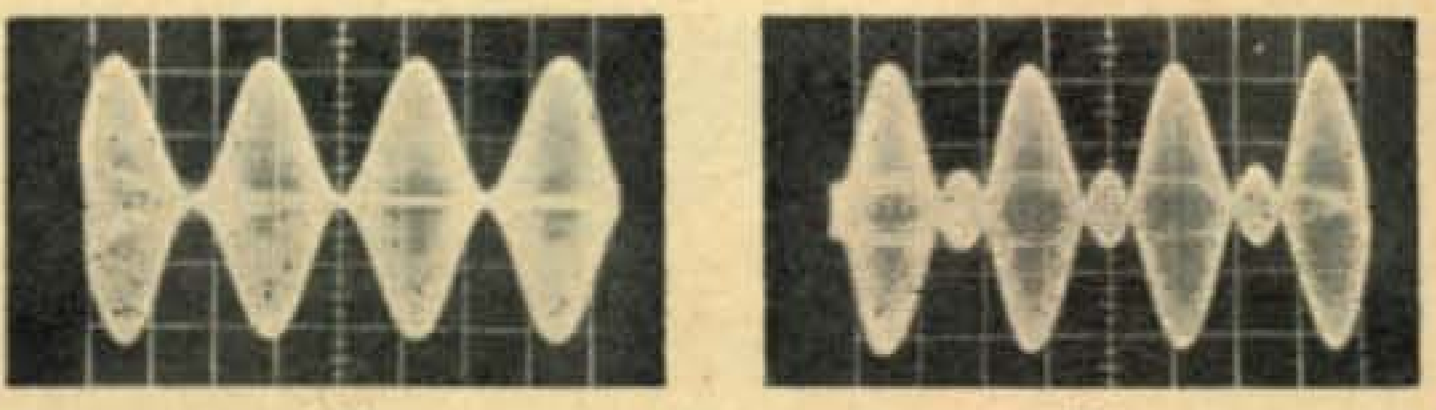

(A) (B)

Fig. 4—A. m. patterns with phasing-type s.s.b. exciter. (A)—100% modulation. (B)—overmodulation, due to excessive a.f. input or insufficient carrier, causes negative peaks to cross over at the horizontal axis.

above 40-50 db suppression, that readings greater than this will be virtually impossible to obtain.

The amount of ripple also hinges on the degree of *carrier* suppression, which in many s.s.b. exciters, may change as the a.f. input level is raised and thus can hinder a good evaluation of the sideband suppression. As a general rule it will always be best to re-balance the carrier for minimum ripple (with uniform peaks) when the a.f. level is set for the desired display amplitude.[3] This level must be below that which indicates overload, as explained next.

When the maximum capabilities of the exciter or the r.f. amplifiers are exceeded, any ripple will tend to disappear completely and the r.f. envelope will look like an unmodulated carrier. What happens here is that overload has set in and "flattopping" is taking place. The maximum allowable operating level (without overload) then is the point just below that where the ripple peaks change and start to flatten. In some cases, a.f. distortion in an exciter may be evidenced when the ripple peaks tend to multiply or become jagged just before flattopping.

In order to become familiar with what is taking place, it would be well to make a few practice observations while making the various adjustments that can produce the situations just described.

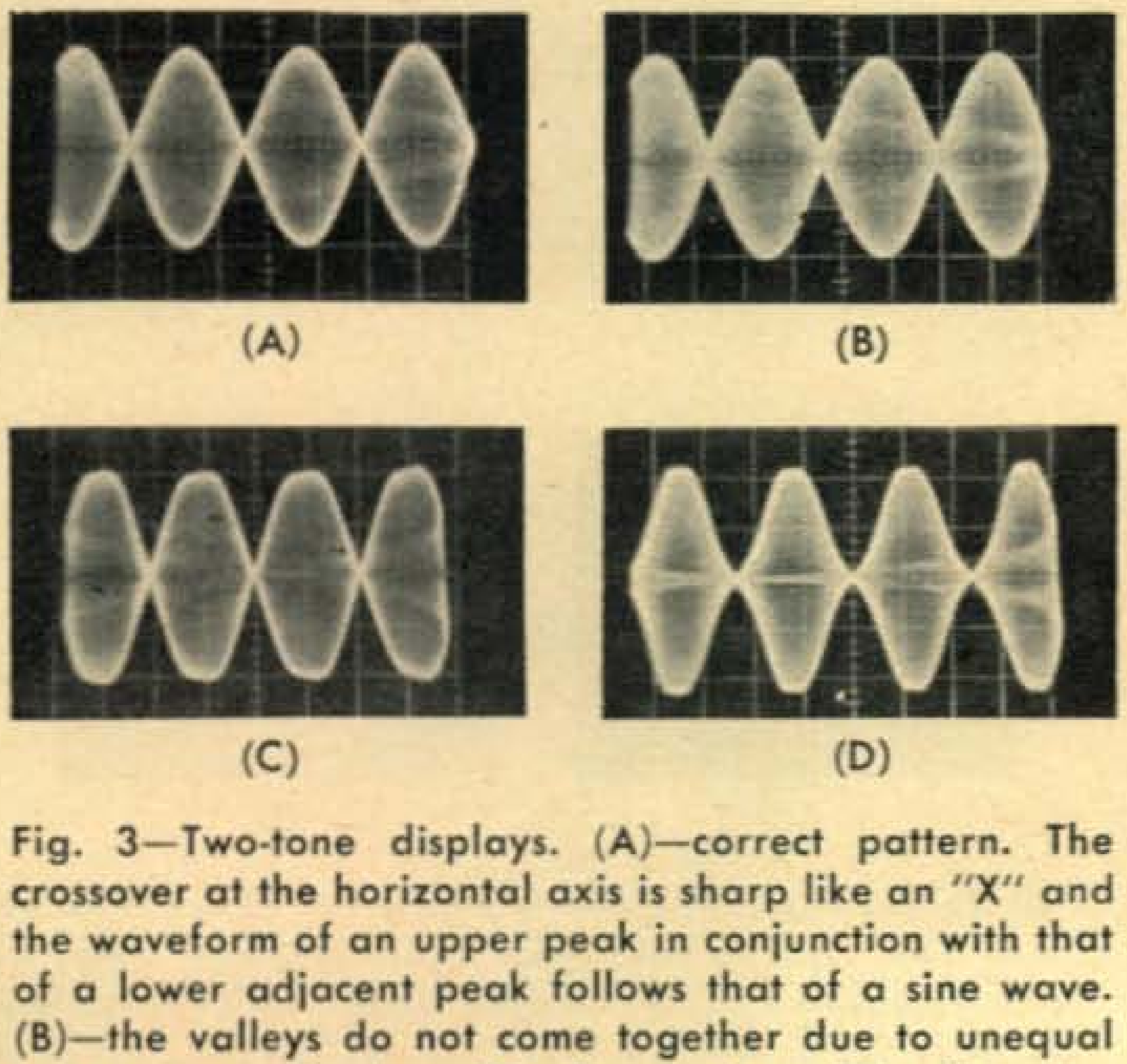
When used for monitoring modulation, the envelope display varies with the voice waveform somewhat like with a.m. Overmodulation is indicated when the crests of the waveforms flattop.

Two-Tone Envelope Displays

Although distortion due to overload can be seen under steady-state conditions using a single tone as shown above, distortion due to many other causes may not readily be evidenced. For such evaluation, two different steady a.f. tones (usually 1000 and 2000 c.p.s.) are simultaneously applied to the s.s.b. gear. The resulting envelope displays are "two-tone" patterns as shown at fig. 3. Non-linearity, or distortion, in an r.f. amplifier is indicated when the shape of a peak above center in conjunction with its adjacent peak below center does not follow the pattern of a true sine wave.

The amplitude of each test tone must be equal to cause the "valleys" to meet along the horizontal axis of the pattern. Where variations in the exciter passband occur at the test frequencies, the level of each applied tone will require readjustment for proper equalization.

Inferior carrier suppression will produce a ripple along the edges of the pattern. Ripple also may be present if the frequencies of the two tones are too closely related, creating beats between them.


(A) (B)

(C) (D)

Fig. 3—Two-tone displays. (A)—correct pattern. The crossover at the horizontal axis is sharp like an "X" and the waveform of an upper peak in conjunction with that of a lower adjacent peak follows that of a sine wave. (B)—the valleys do not come together due to unequal test-tone amplitudes. (C)—flattopping. (D)—distortion due to incorrect bias produces S-shaped crossover points. Flattopping also is shown.

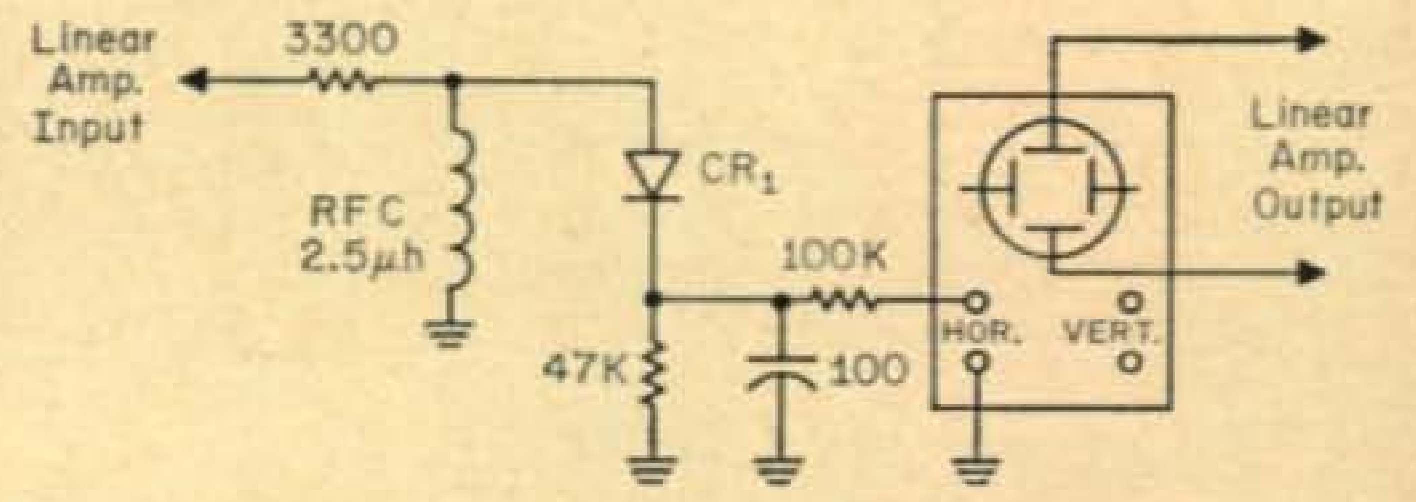


Fig. 5—R.f. envelope detector as used for obtaining trapezoid displays of linear-amplifier operation. The peak r.f. input potential to the detector should be held below 50 volts with a voltage divider as shown at fig. 8, page 61, CQ, Sept., 1966. Higher voltages may be safely handled using a vacuum tube in place of CR_1.

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[3] The number of ripple peaks due to carrier leakage will be half those representing sideband suppression. At very high degrees of both sideband and carrier suppression, it may be difficult to distinguish between them.

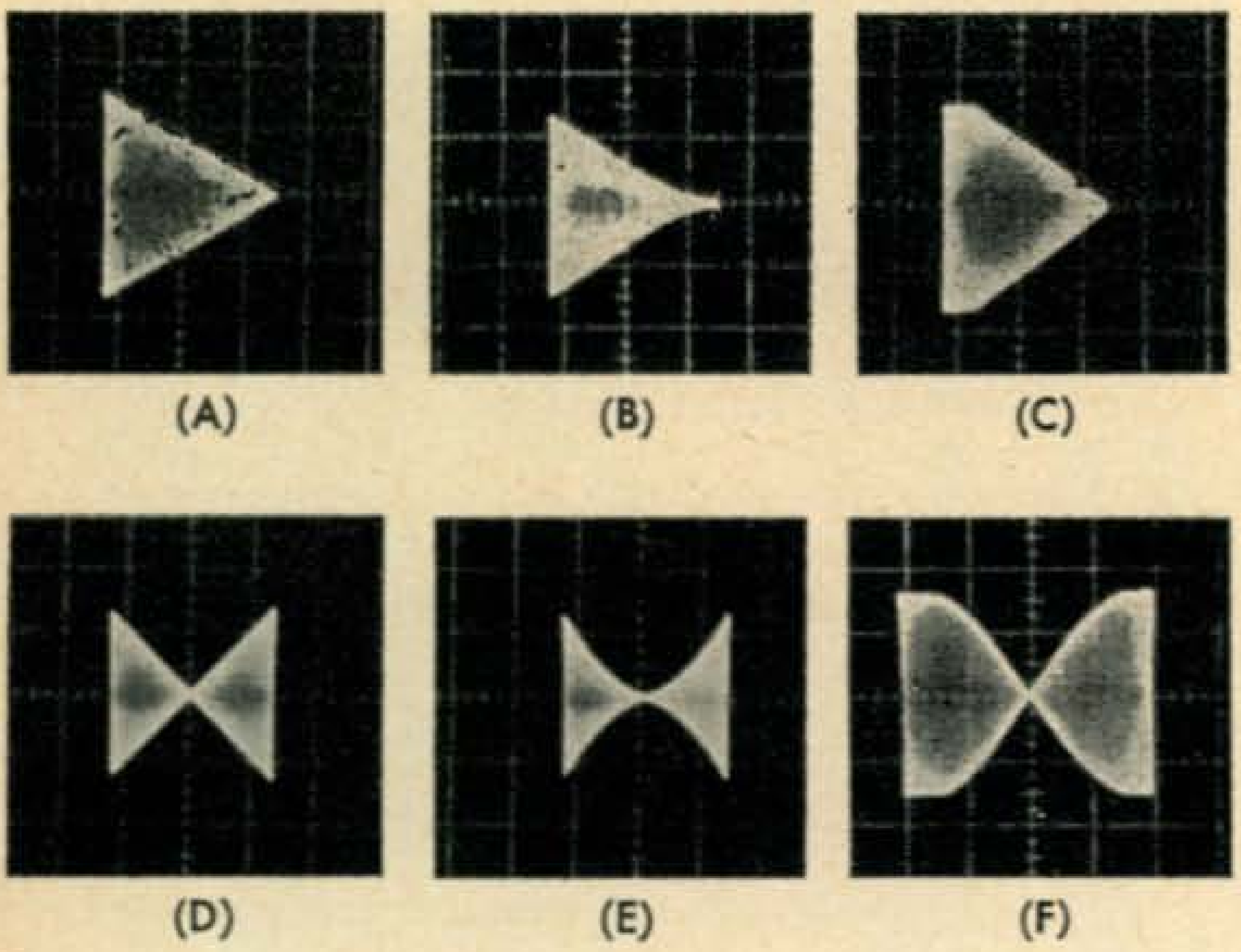

Fig. 6—At the top—trapezoid displays. At the bottom—double-trapezoid or bow-tie displays obtained with a phasing exciter. (A) and (D)—straight slopes indicate good linearity. (B) and (E)—curved slopes indicate poor linearity and distortion, in this case due to incorrect bias on p.a. (C) and (F)—flattopping due to excessive drive. Both sides of the bow-tie will not be the same size if the working modulator is not completely balanced, but this is not necessary for correct observations.

Two-tone displays may be obtained using a *phasing*-type exciter while only a *single* tone is applied. To do this: disable one of the balanced modulators by removing the a.f. applied to it (a short across its a.f. feed will do the trick) and then unbalance the carrier for *this* modulator *only*. Unbalancing the carrier for the *working* modulator will produce an a.m. display as shown at fig. 4.

A two-tone display also may be obtained with a filter-type exciter using a single tone. This is done by inserting the amount of carrier that produces the proper display.

Trapezoid Displays

Trapezoid patterns with s.s.b. gear usually are used for checking and monitoring linear amplifier performance; however, an evaluation of the overall r.f. lineup also may be obtained.

For observing linear-amplifier performance the amplifier output is applied to the vertical plates of the oscilloscope and a sample of the r.f. input signal from the exciter is demodulated with an envelope detector, the a.f. output of which goes to the horizontal amplifier of the scope as shown in fig. 5. The application of a two-tone a.f. signal to the exciter will then produce a trapezoid display from which the presence of distortion may be found by noting whether or not the trapezoid exhibits straight slopes. See fig. 6. A curvature at the top and bottom corners indicates flattopping which, during voice modulation, serves as a useful monitoring indication of maximum permissible operating levels.

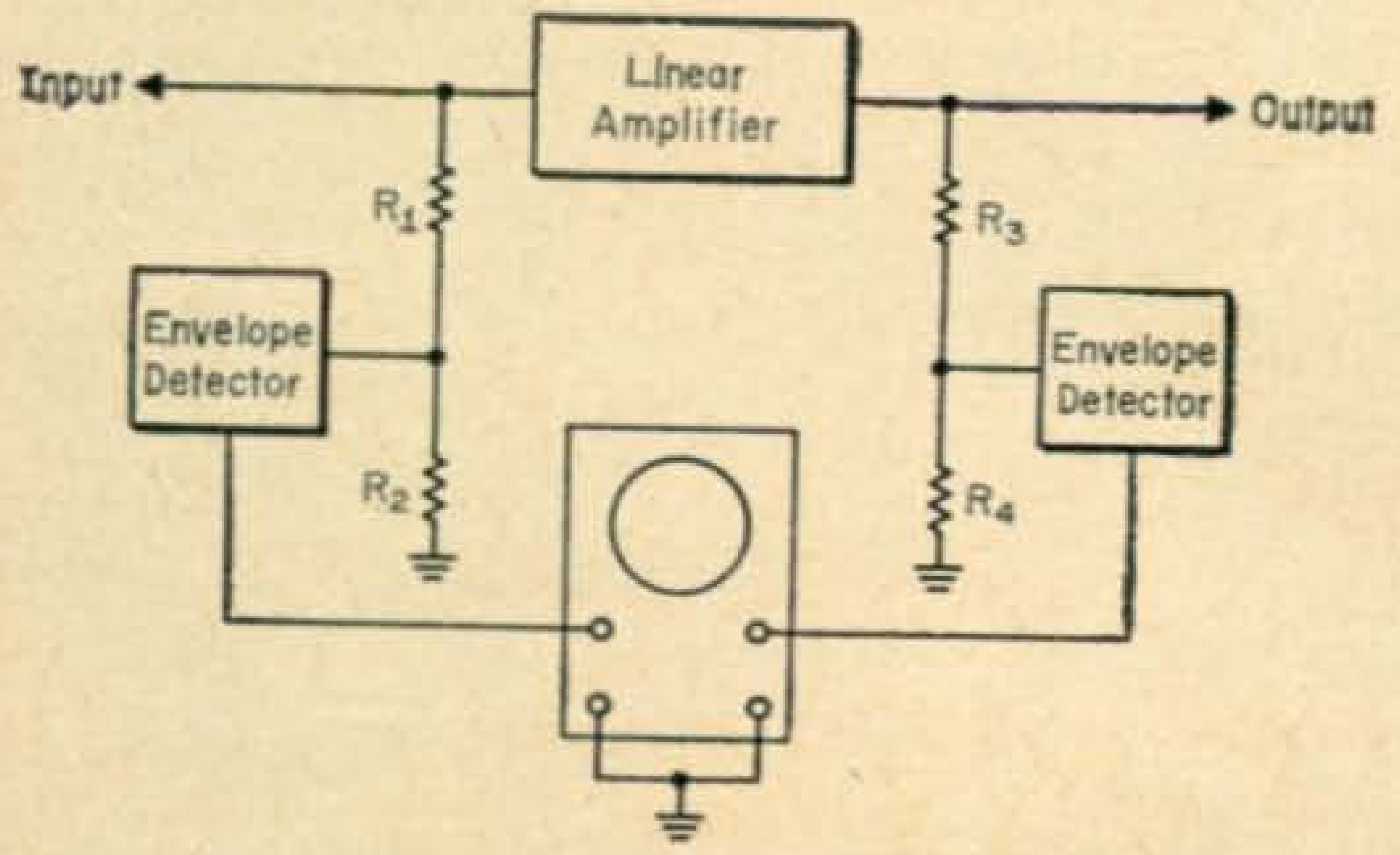

Fig. 7—Arrangement using envelope detectors for obtaining single-line input-output comparison displays with a linear amplifier. Resistors R_1-R_2 and R_3-R_4 should be proportioned so that equal voltages will be applied to the detectors to ensure the best inherent linearity of the setup.

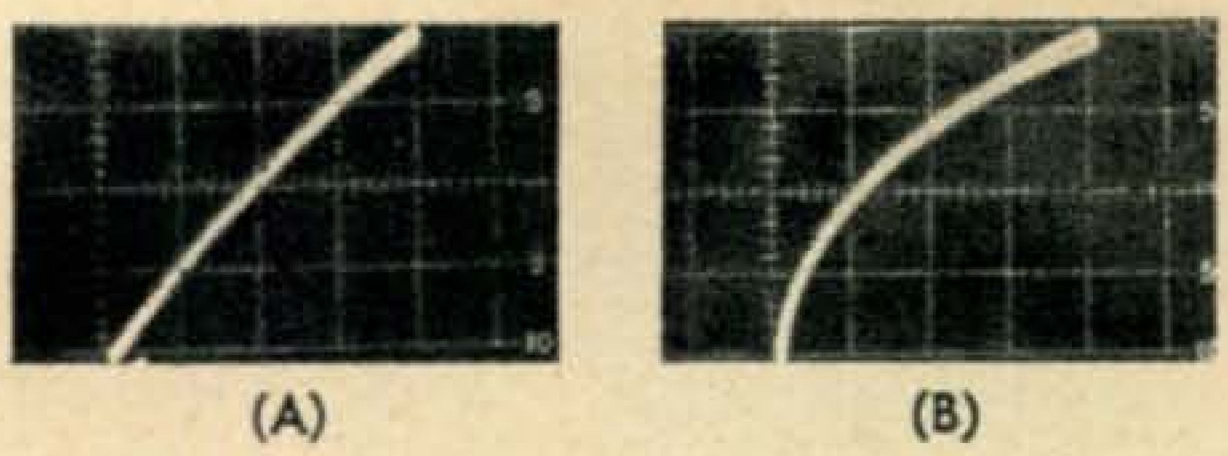

Fig. 8—Single-line input-output comparison displays. Perfect linearity would produce a straight slope. (A)—a small amount of non-linearity is indicated by the slight curvature of the tract. (B)—severe distortion is indicated.

A two-tone signal produced by a phasing exciter will create a double-trapezoid, or a bow-tie, pattern as shown at fig. 6. It will also provide an evaluation of the entire r.f. lineup in the s.s.b. gear.

Single-Line Demodulated Displays

Instead of a trapezoid, a demodulated display with only a single-line trace for an input-output comparison may be obtained by applying a two-tone a.f. signal and employing envelope detectors at both the input and output of the linear amplifier, as shown in fig. 7. As with the trapezoid, any departure from a straight line indicates the *presence* of distortion.[4] See fig. 8.

A single-line display of only the a.f. component on the s.s.b. r.f. envelope can be obtained using the demodulator probe with a direct-coupled vertical amplifier in the oscilloscope. The arrangement and procedure are the same as de-

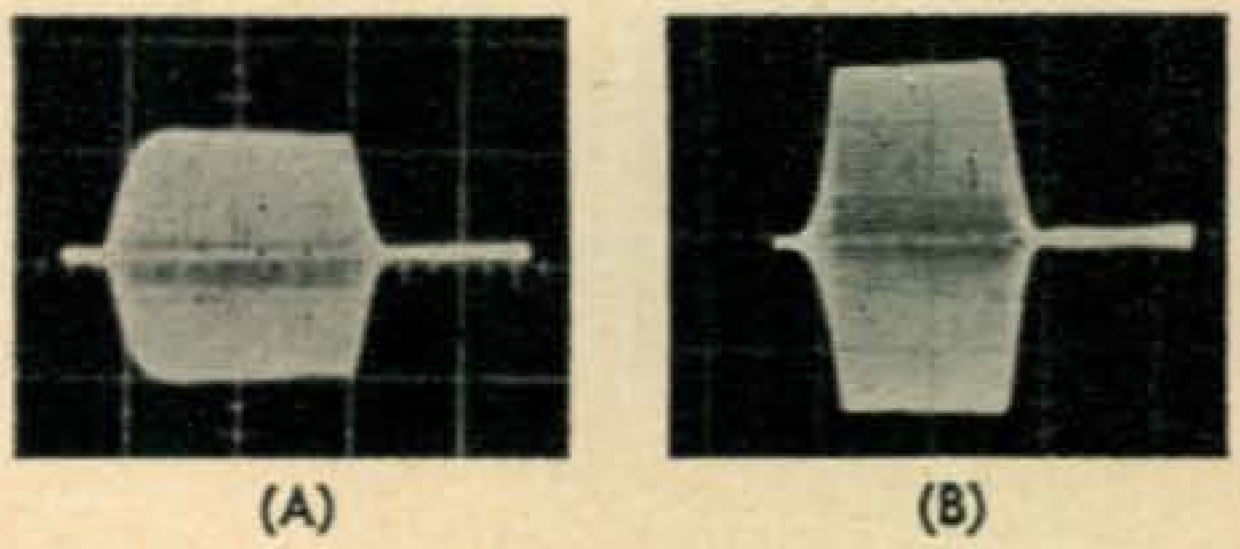

Fig. 9—Envelope displays showing c.w. keying waveform. (A)—due to the more gradual slope and the rounded corners on the leading edge (left) this pattern indicates softer keying than that at (B) which has a sharp-cornered waveform. A slight key click may result with (B). Spikes at either edge would indicate severe key clicks.

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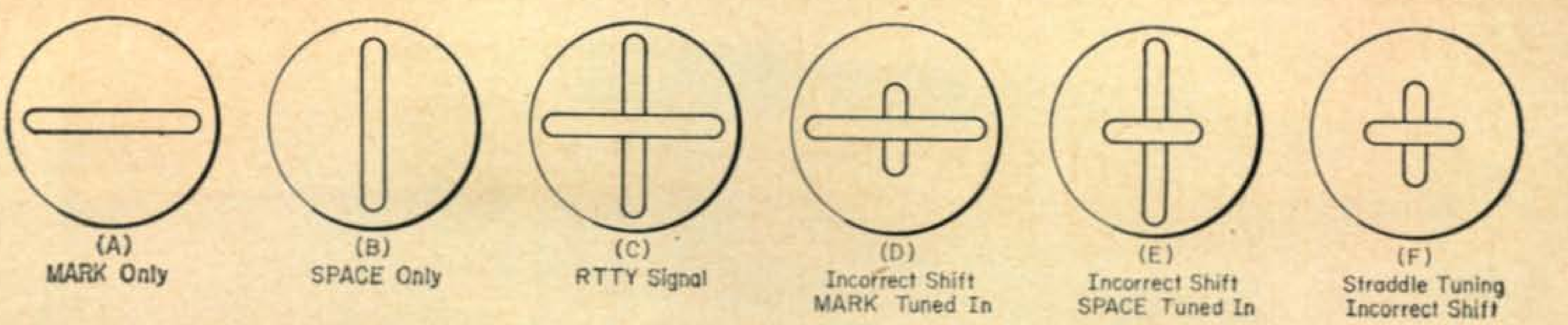
[4] A method for determining the signal-to-distortion ratio may be found in "*Single Sideband Principles and Circuits*" by Pappenfus, Bruene and Schoenike, page 362; published by McGraw-Hill.



(A) MARK Only

(B) SPACE Only

(C) RTTY Signal

(D) Incorrect Shift MARK Tuned In

(E) Incorrect Shift SPACE Tuned In

(F) Straddle Tuning Incorrect Shift

Fig. 10—R.T.T.Y. cross patterns obtained using the oscilloscope.

scribed for a.m.,[5] except as follows:

After setting up the initial horizontal-reference line near the bottom of the c.r.t. screen as described in step 4 of the referred-to procedure, turn on the transmitter and apply a single a.f. tone, at near normal operating level, and advance the vertical gain of the scope. The horizontal trace will move toward the top of the c.r.t. by an amount depending on the vertical-gain setting and on the modulating level. Instead of remaining a straight line however, the trace will be rippled according to the degree of unwanted-sideband suppression, just as indicated at the edges of the s.s.b. envelope patterns. See fig. 1. The degree of suppression is found as indicated at fig. 2(B). The effects of inferior *carrier* suppression and of overloading also will be evidenced as described for the envelope displays.

The single-line patterns can be made quite sharp and brilliant, thus allowing more accurate observation than with envelope patterns. They also will be found excellent for monitoring which then can be had using a scope that is not equipped with r.f. input connections.

Peak Power

The application of carrier alone will produce the usual unmodulated r.f. envelope display as with a.m. Knowing the input or output power under steady-state conditions (d.c. or tuneup power) the peak power during modulation can be found by noting the percentage amplitude increase by which the p.e.p. exceeds the steady-state level. The oscilloscope indicates voltage changes, and since power varies as the square of the voltage, the p.e.p. can then be calculated from $\text{p.e.p.} = (\%\ \text{level increase} + 100\%)^2 \times$ steady-state power.

C.W.

C.w. keying characteristics may be observed using r.f. envelope displays. This is best done

[*Continued on page 102*]

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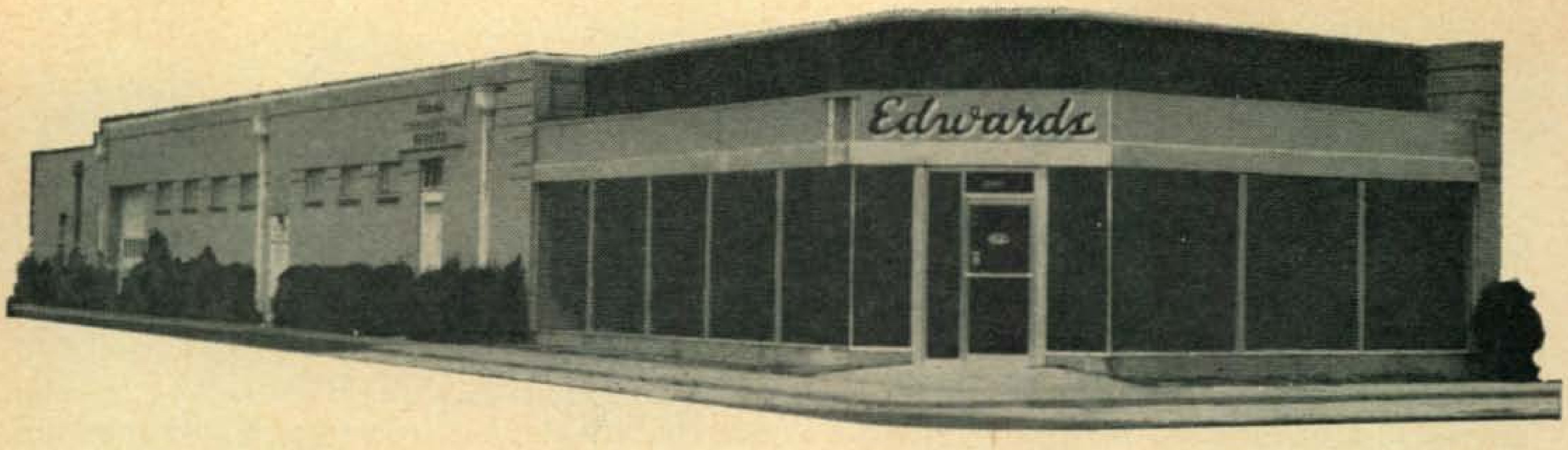
[5] See page 60-61, *CQ*, Sept. 1966.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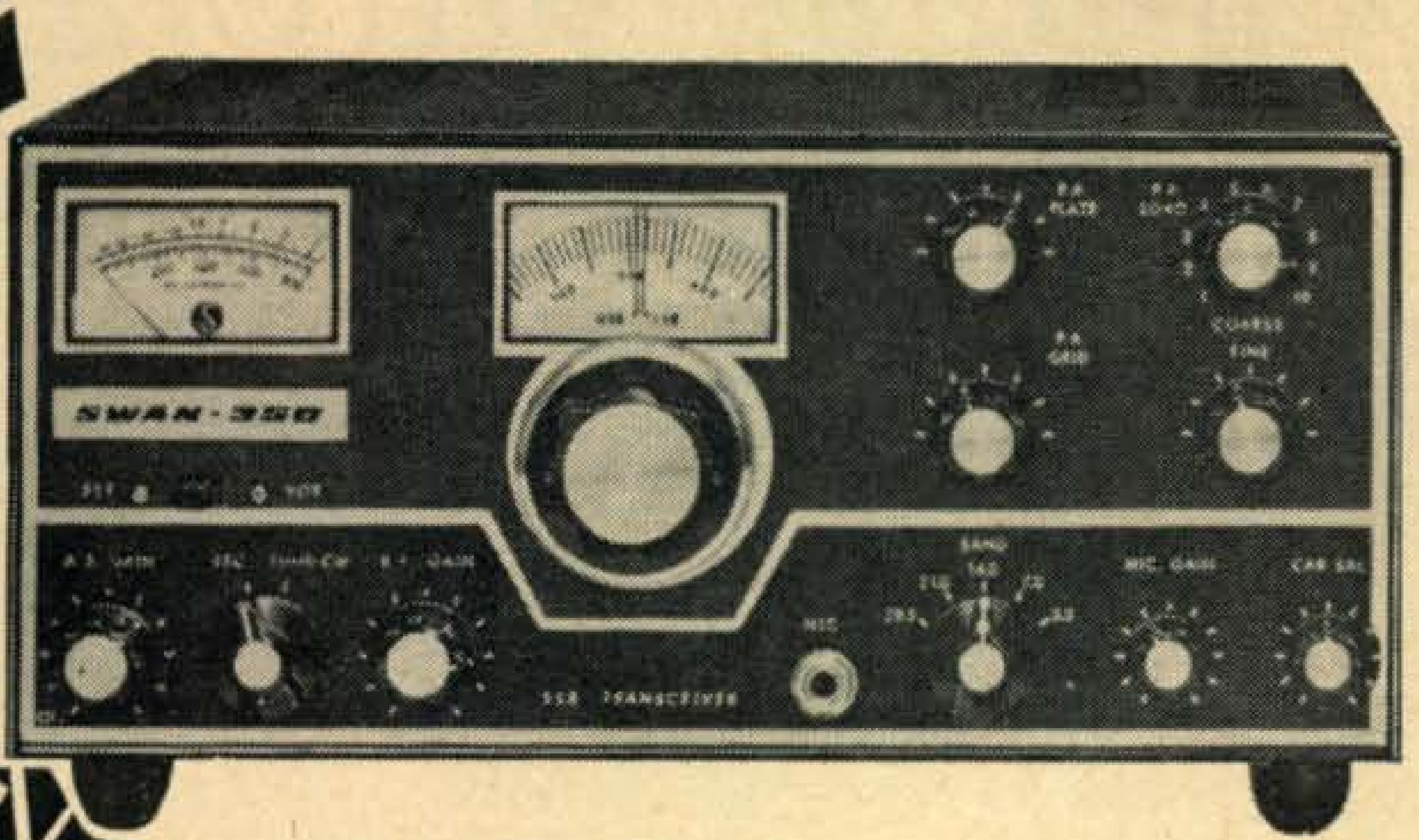

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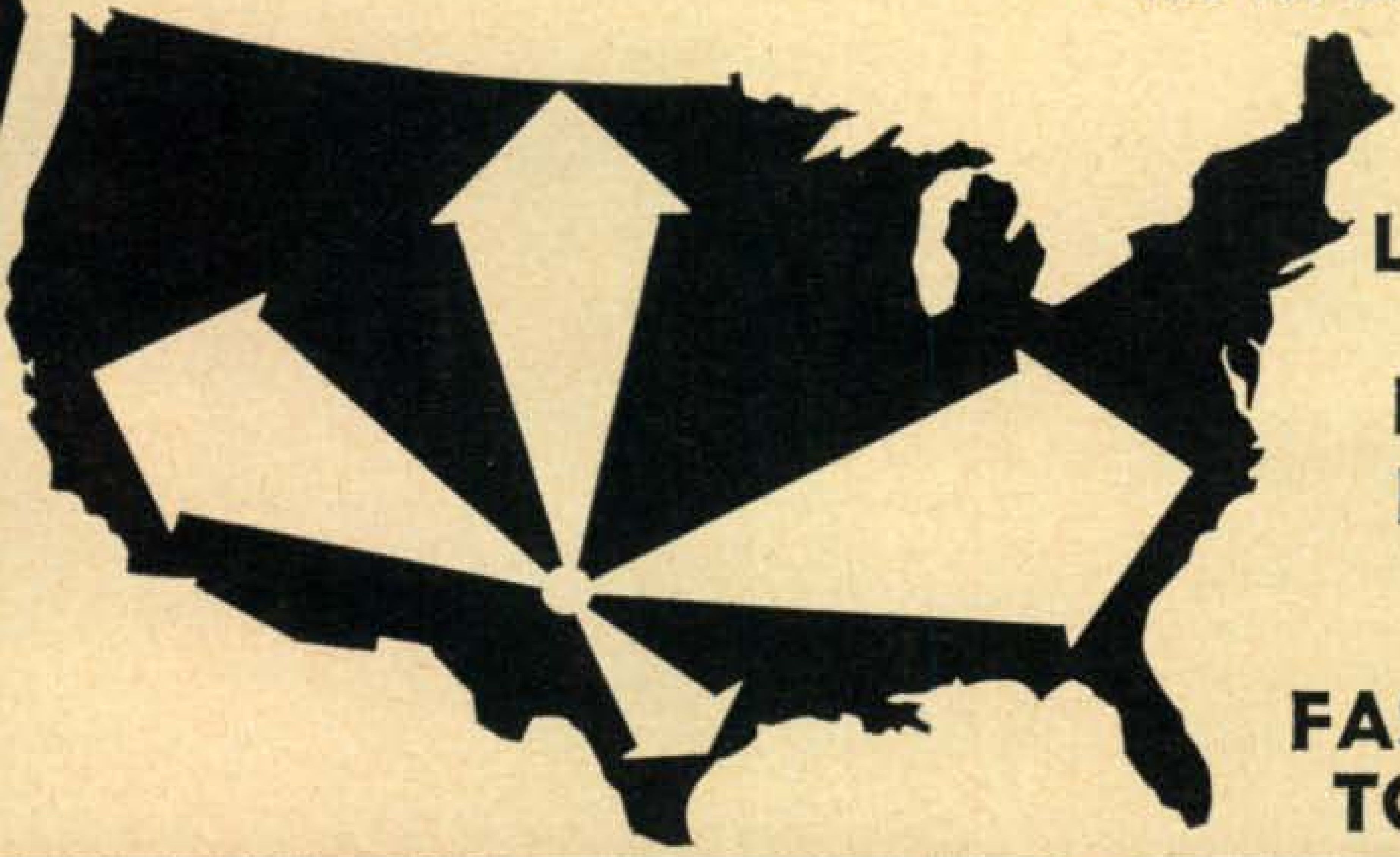

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Roll Your Own Low Pass Filters

BY HARVEY KOFSKY,* VE2BNK

With the information presented below any person who can do simple arithmetic can design and construct his own low pass filters. The filter will be tailor-made to match the exact frequency and impedances desired.

THE pi and T-network are common filters that every ham has encountered in many of his projects. It is these filters and their application that can remove many spurious signals and prevent DOT and O.O. QSL cards. Unless your particular filter problem has been covered in some magazine, you are likely going to have to rely on a cut and try method of design. Most books on radio theory pay little attention to problems of filter design and instead of clear cut design procedures, your book searching will probably only yield a few charts together with a simple example. If you are lucky, this example will approximate your own. However, it has been the author's experience that no resemblance can usually be found.

It is the purpose of this article to enable any person who can do simple arithmetic and understand elementary algebraic equations to design professional filters. These filters can be designed for any frequency and for any impedance requirements. The time taken will vary from 25 to 40 minutes of calculations depending on how quickly you can manipulate a slide rule or pencil.

The attenuation network we will put together is composed of 3 separate stages. Each stage builds from the first in logical and easily understood steps. As a starting point, we will use the network in fig. 1(A).

Figure 1(A) is a common T filter in which the input impedance equals the output impedance and the inductors in either side of the capacitors have equal value. Such a unit is called a prototype constant K symmetrical low pass filter.

Figure 1(B) is the same circuit as fig. 1(A) except the filter has been split into two half sections. As can be seen, by joining the dotted line and replacing the capacitors by a single capacitance, we have fig. 1(A) again.

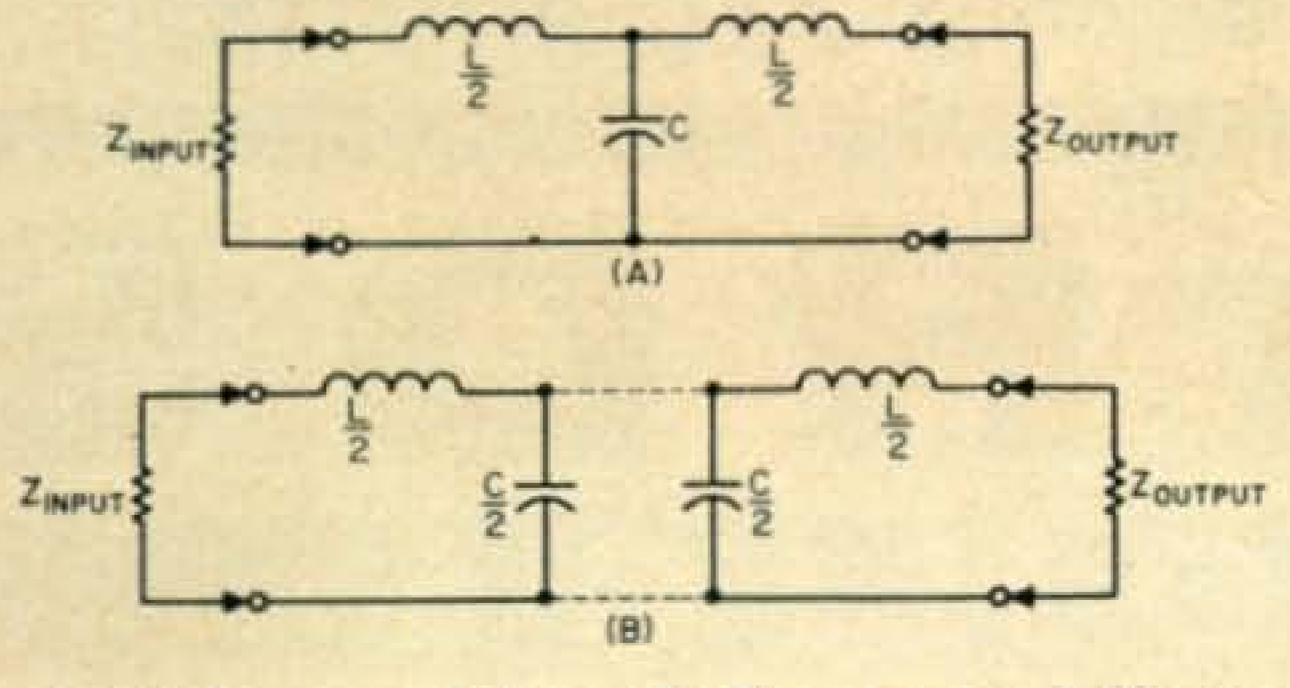


Fig. 1 (A) Common T filter. (B) The common T filter split in two sections.

Figure 2(A) and 2(B) indicate the changes needed to rearrange fig. 1(A) and 1(B) into a pi-network.

A word about convention is best introduced here. We could easily give the inductors the symbol L instead of $L/2$, but for reasons which will become apparent when you need to substitute numbers into the formulas, the representation used here will eliminate a lot of mechanical work. This convention should pose no problems if the reader remembers to build his filter from the circuit diagram and note what value of inductance he is using.

Both filters, the T and Pi, are electrically similar; the formulas used and the results obtained are identical and it makes no difference which circuit is actually built. For purposes of clarity, the brief explanations given for the formulas that will be used will be based on the T network.

Examining fig. 1b, we can see that inductor $L/2$ and capacitor $C/2$ form a resonant circuit at a frequency that is given by:

$$f = \frac{1}{2\pi\sqrt{\frac{L}{2}\,\frac{C}{2}}} \tag{1}$$

At this frequency our input signal will be shorted to ground effectively cutting off our output. Therefore, we have the cutoff frequency:

$$f_c = \frac{1}{\pi\sqrt{L\,C}} \tag{2}$$

The input impedance of the T network can be shown to be equal to:

$$Z_{in} = Z_{out} = \sqrt{\frac{L}{C}} \tag{3}$$

Combining equation 2 and 3 enables us to compute the component values needed for any cut off frequency (f_c) and impedance we may want to use.

---

*2147 Bedford Road, Montreal 26, Quebec, Canada.

$$L = \frac{Z_{in}}{\pi f_c} \qquad (4)$$

$$C = \frac{1}{\pi Z_{in} f_c} \qquad (5)$$

This is all we have to know to design our prototype and as can be seen from the example shown below the arithmetic may be the only difficult part.

Application

An operator, who is tired of 75 meter rag chewing, decides to build a transmitter for 6 meters. He wishes to feed a 52 ohm antenna and the frequency he will operate is 51.5 megacycles. In order to prevent TVI on Channel 2 he decides to design a low pass filter that will cut off at 52 megacycles. Actually he wants high attenuation at the band edges, 54 megacycles, but he decides to play safe and cut his signal off at 52 mc. Using equations 4, 5, we have:

$$L = \frac{Z_{in}}{\pi f_c} = \frac{52}{3.141 \cdot 52 \cdot 10^6} = 0.381 \ \mu h \quad (6)$$

$$C = \frac{1}{\pi Z_{in} f_c} = \frac{1}{3.141 \cdot 52 \cdot 52 \cdot 10^6} = 117 \ mmf \quad (7)$$

Since for a T filter, the required inductor value is one half of *L*, we have:

$$L = \frac{0.318}{2} = 0.159 \ \mu h \qquad (8)$$

Figure 3, curve (*A*), illustrates the attenuation characteristics of this filter. At 54 mc we have only about 7 db attenuation. Evidently we should attempt to increase this value or retire back to 75 phone or find an area with no television receivers.

M Derived T Sections

To improve the performance of this filter we have to add a second section. This is an M derived T section illustrated in fig. 4(A). By using the *L* and *C* values developed from equations (6) and (7) and multiplying them by the constants shown in fig. 4(A), we can derive the required values for the new T section.

Only one new constant is contained in fig. 4(A); it is the unknown, *m*. It is sufficient, here, to present the formula for *m* and disregard its derivation.

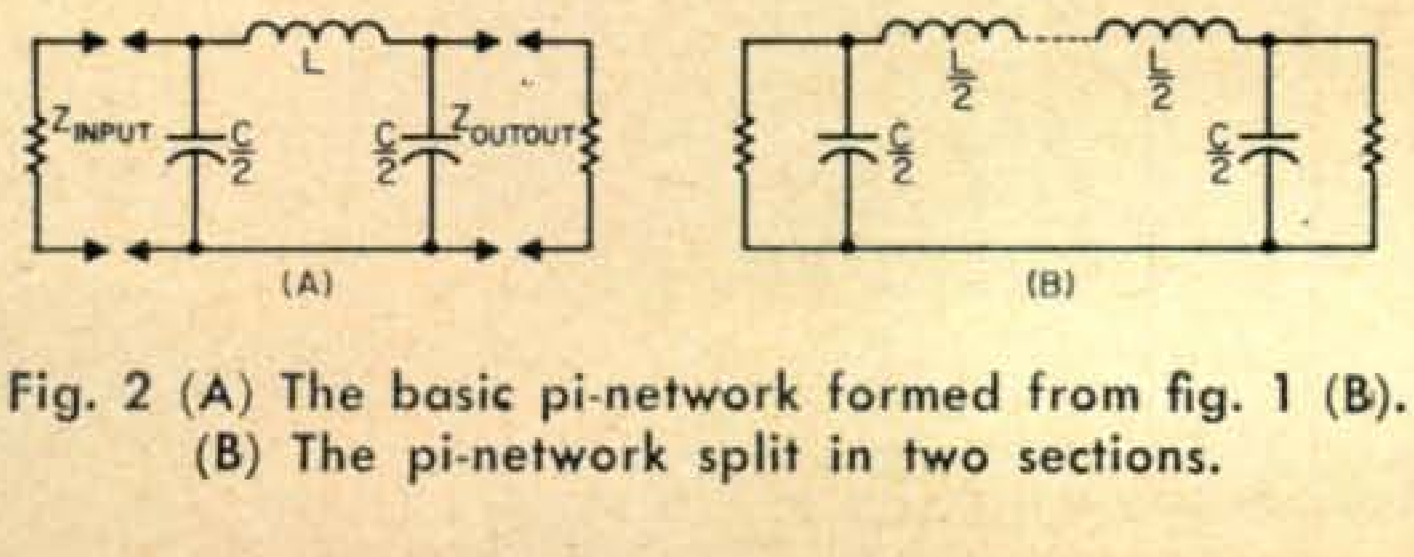


Fig. 2 (A) The basic pi-network formed from fig. 1 (B). (B) The pi-network split in two sections.

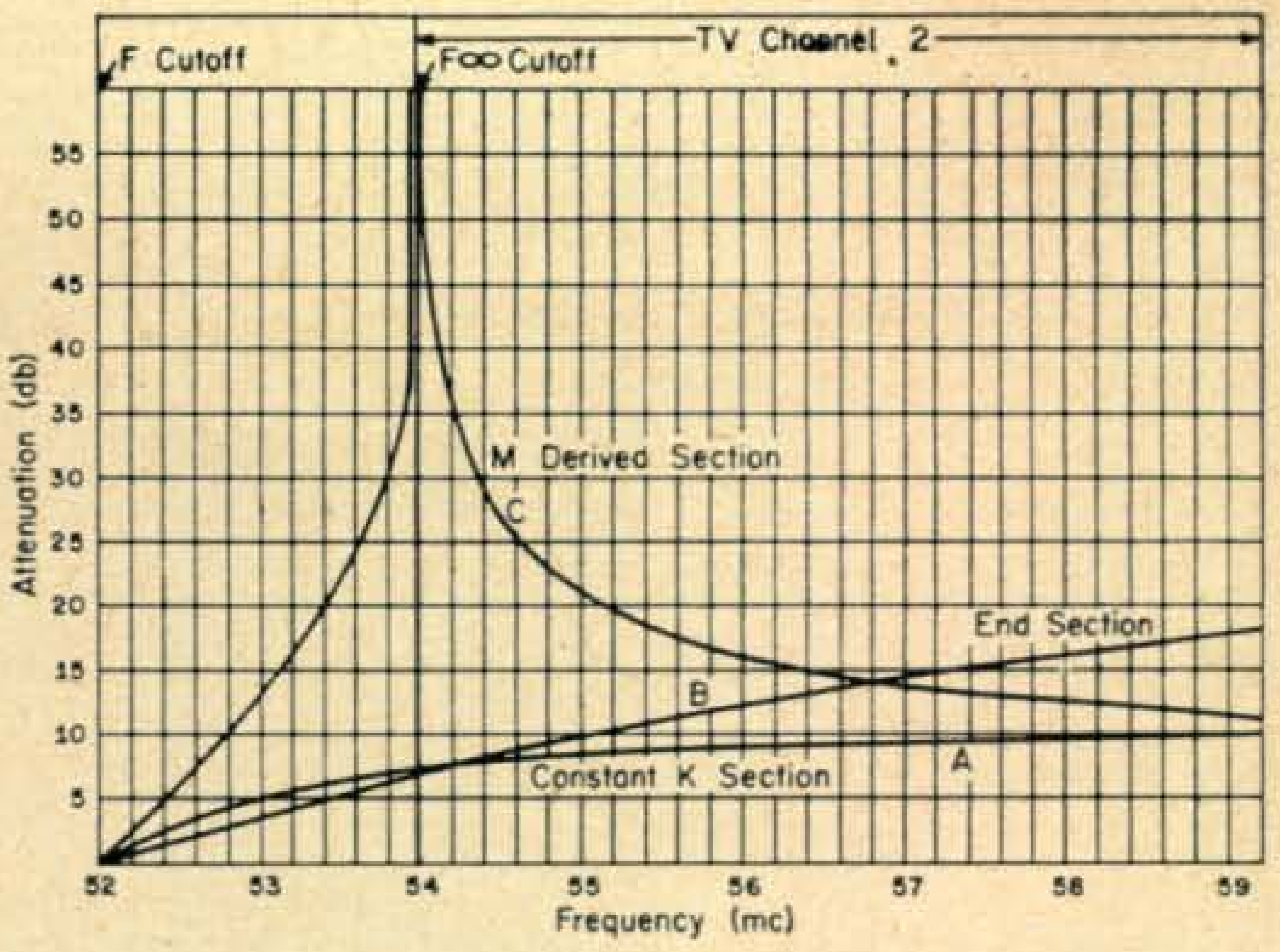


Fig. 3—Attenuation characteristics of the various filter sections. Curve C is actually the left vertical curve.

$$m = \sqrt{1 - \left(\frac{f_c}{f\infty}\right)^2} \qquad (9)$$

The cutoff frequency, f_c, is as previously indicated, 52 mc. The frequency at which we wish to obtain maximum attenuation, f_{∞}, is in this case, 54 mc.

Solving for *m*, we get:

$$m = \sqrt{1 - \left(\frac{52}{54}\right)^2} = 0.265 \qquad (10)$$

By referring to fig. 4(A) and solving for the component values of the T section, we have:

$$Inductor\ A\ and\ B = \frac{m\,L}{2} = \frac{0.265 \cdot 0.318}{2} = 0.042 \ \mu h \qquad (11)$$

$$Inductor\ C = \left(\frac{1 - m^2}{4\,m}\right) L = \left(\frac{1 - .07}{4 \cdot 0.265}\right) 0.318 = 0.288 \ \mu h \quad (12)$$

$$Capacitor = m\,c = 0.265 \cdot 117 = 31 \ mmf \quad (13)$$

These values are shown in the circuit of fig. 4(B)

A look at the attenuation characteristics for the M derived T section in fig. 3, curve (*C*), shows the improved suppression in the Channel 2 area.

End Sections

Having gone this far it would be foolish to forget or omit the finishing touches. The input

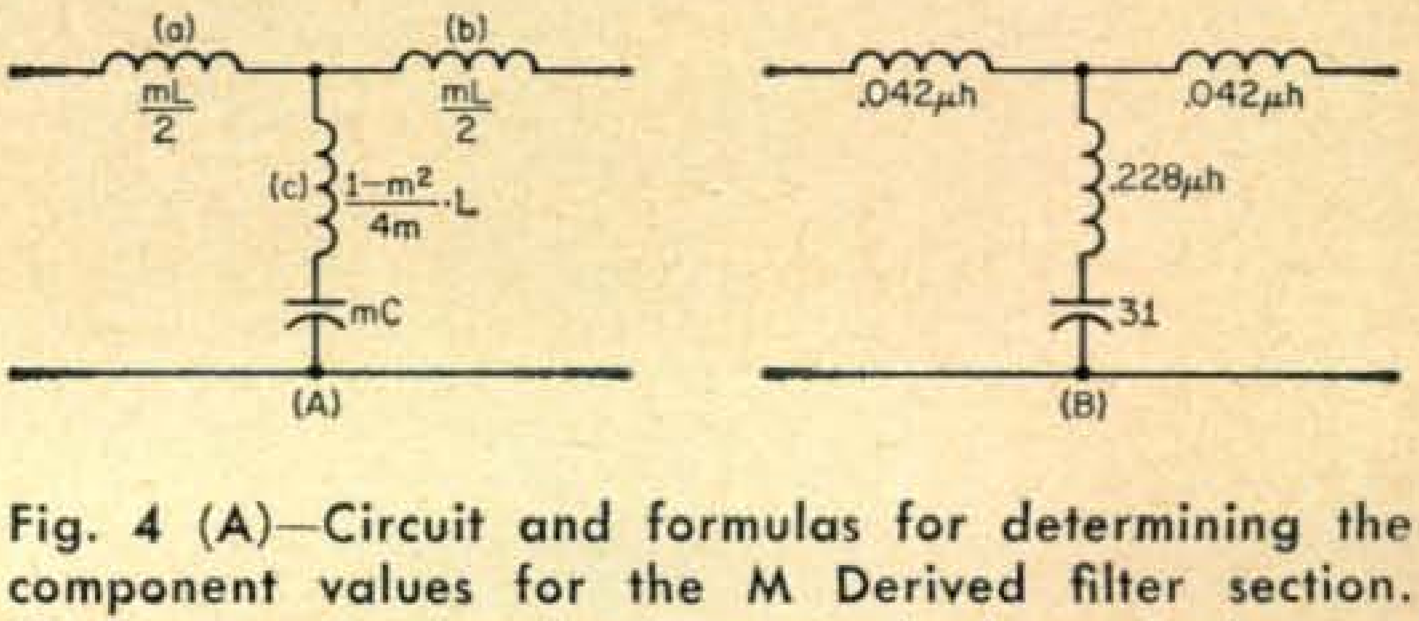


Fig. 4 (A)—Circuit and formulas for determining the component values for the M Derived filter section. (B) Computed values for the example chosen in the text.

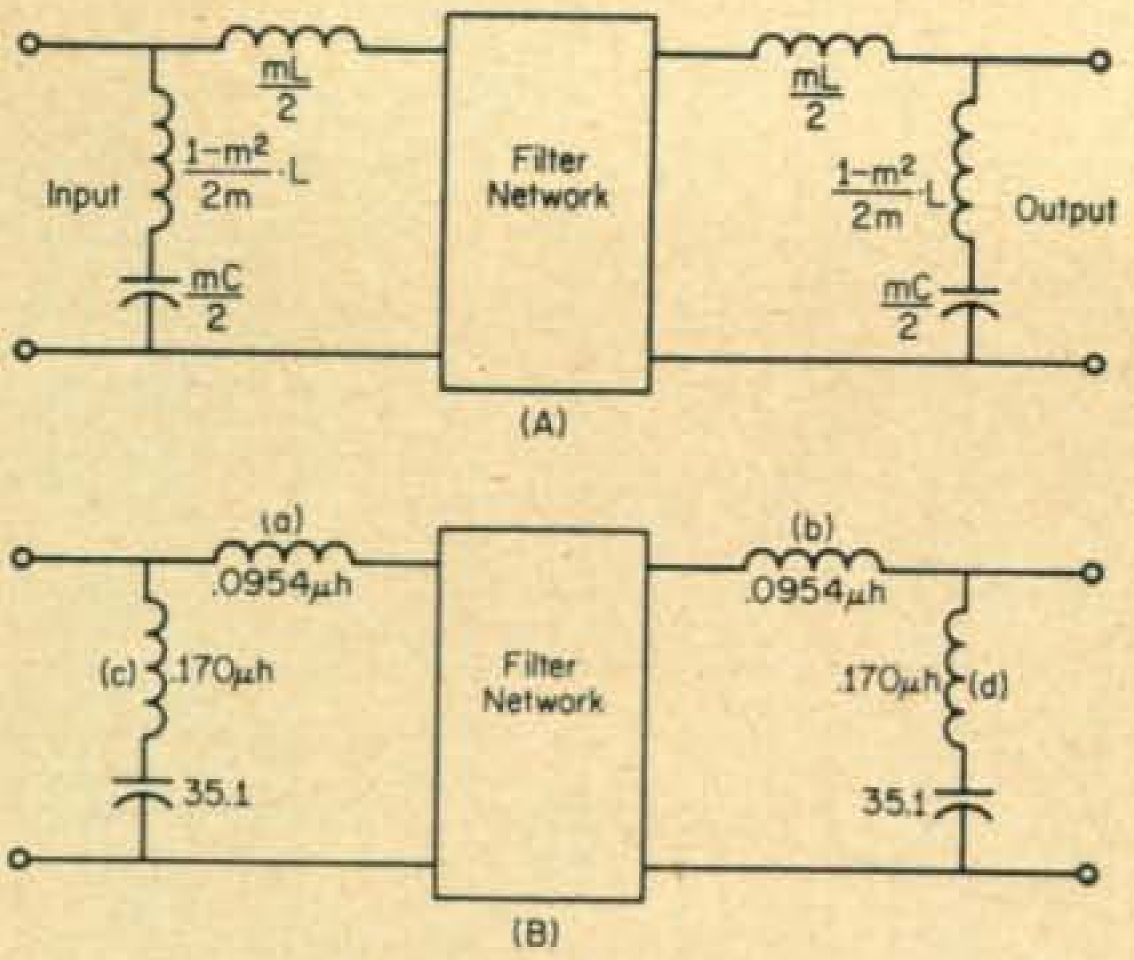


Fig. 5 (A)—Circuit and formulas for determining the component values of the end sections. (B) Computed values for the example chosen in the text.

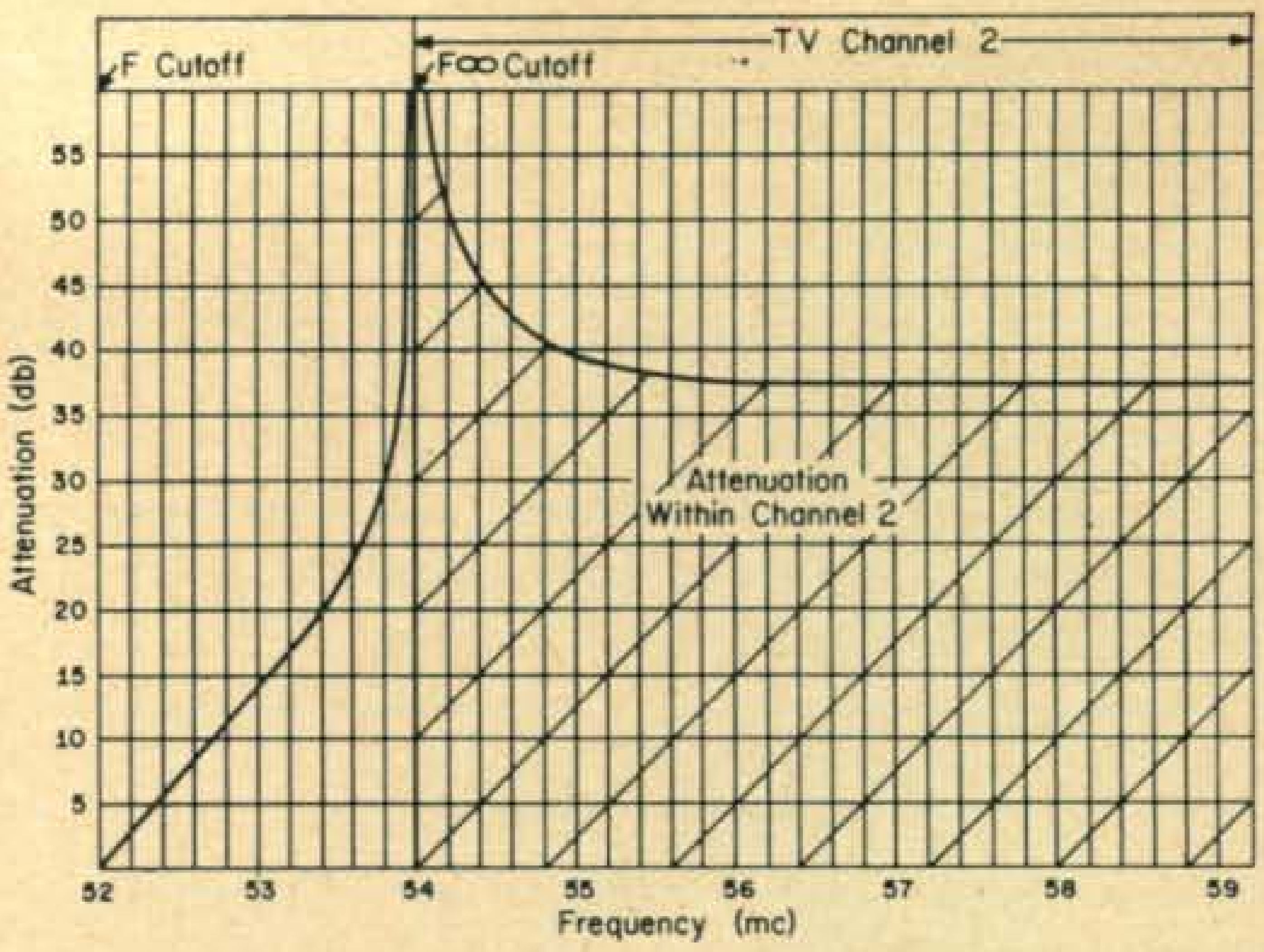


Fig. 7—Attenuation characteristics of the complete filter illustrated in fig. 6(B).

and output impedances of the network are not constant but vary with frequency. To correct this the use of half sections, shown in fig. 5, are required.

In this case, so far, we have determined L and C from equations (6) and (7). Now m in fig. 5(B), poses no problem as its value is always equal to 0.6 when designing half sections. Substitution of the required numbers enables determination of the required values and gives us the working circuit of fig. 5(B). The calculations are illustrated below.

$$\text{Inductor } A \text{ and } B = \frac{m\,L}{2} = \frac{0.6 \cdot 0.318 \cdot 10^{-6}}{2} = 0.0954\ \mu h \qquad (14)$$

$$\text{Inductor } C \text{ and } D = \left(\frac{1 - m^2}{2m}\right) \mathrm{L} = \left(\frac{1 - 0.6^2}{2 \cdot 0.6}\right) 0.318 \times 10^{-6} = 0.170\ \mu h \qquad (15)$$

$$C = \frac{m\,c}{2} = \frac{0.6 \cdot 117 \cdot 10^{-6}}{2} = 35.1\ mmf$$

Remember, you must use the values of L and C that where obtained in the calculation of the prototype section in equations (6) and (7).

A look at the attenuation characteristics of the end sections shown in curve (B) of fig. 3 show an additional 5 to 10 db of suppression throughout Channel 2.

Assembly

Assembling our three stages as illustrated in fig. 6(A) requires that the series inductors be added for the final result to produce the final circuit of fig. 6(B).

A reminder, though, before you buy your components. The formulas do not contain any correction for resistance of the coils, therefore, high Q coils are a *necessity* for proper operation.

Construction of the unit should not pose any difficulties in the operation of the unit. There are, however, two criteria that should be observed: mount your inductors at least 2 coil diameters apart, and where possible keep the coils perpendicular to each other. A look at fig. 6 will give you an idea of how to mount the components. Remember, follow good T.V.I. prevention techniques.

A look at the attenuation characteristics of the complete filter (fig. 7) shows us that for Channel 2 we are protected by about a 37 db loss of any signal that could cause trouble. If, however, you wish to increase this value, just put another m section into the unit.

Well, it's done. Regardless of the application, the low pass filter designed here is just as good electrically as any professional storebought device. The added features will put an end to inefficient low pass filters and you will be able to relax the next time you operate, with the knowledge that, insofar as filters go, you've got the best. ■

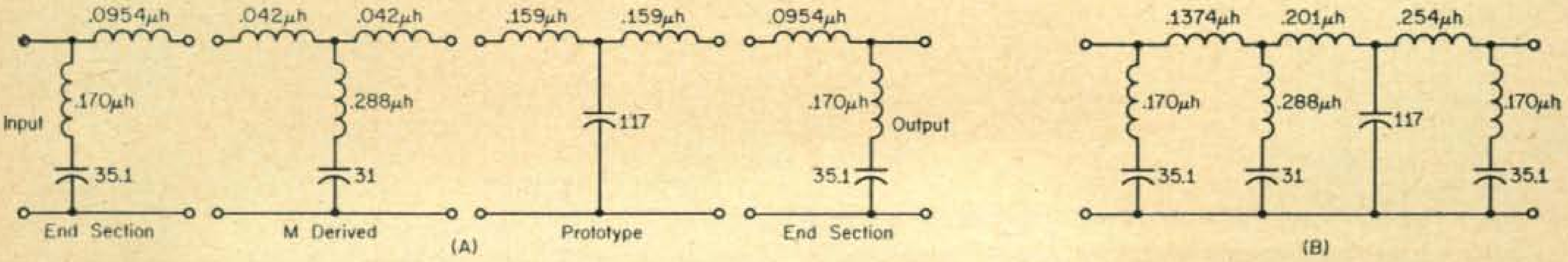


Fig. 6 (A)—Combined view of the four filter sections. (B) Final form of the filter after series inductor values have been added.

A TUNED LINEAR INPUT NETWORK

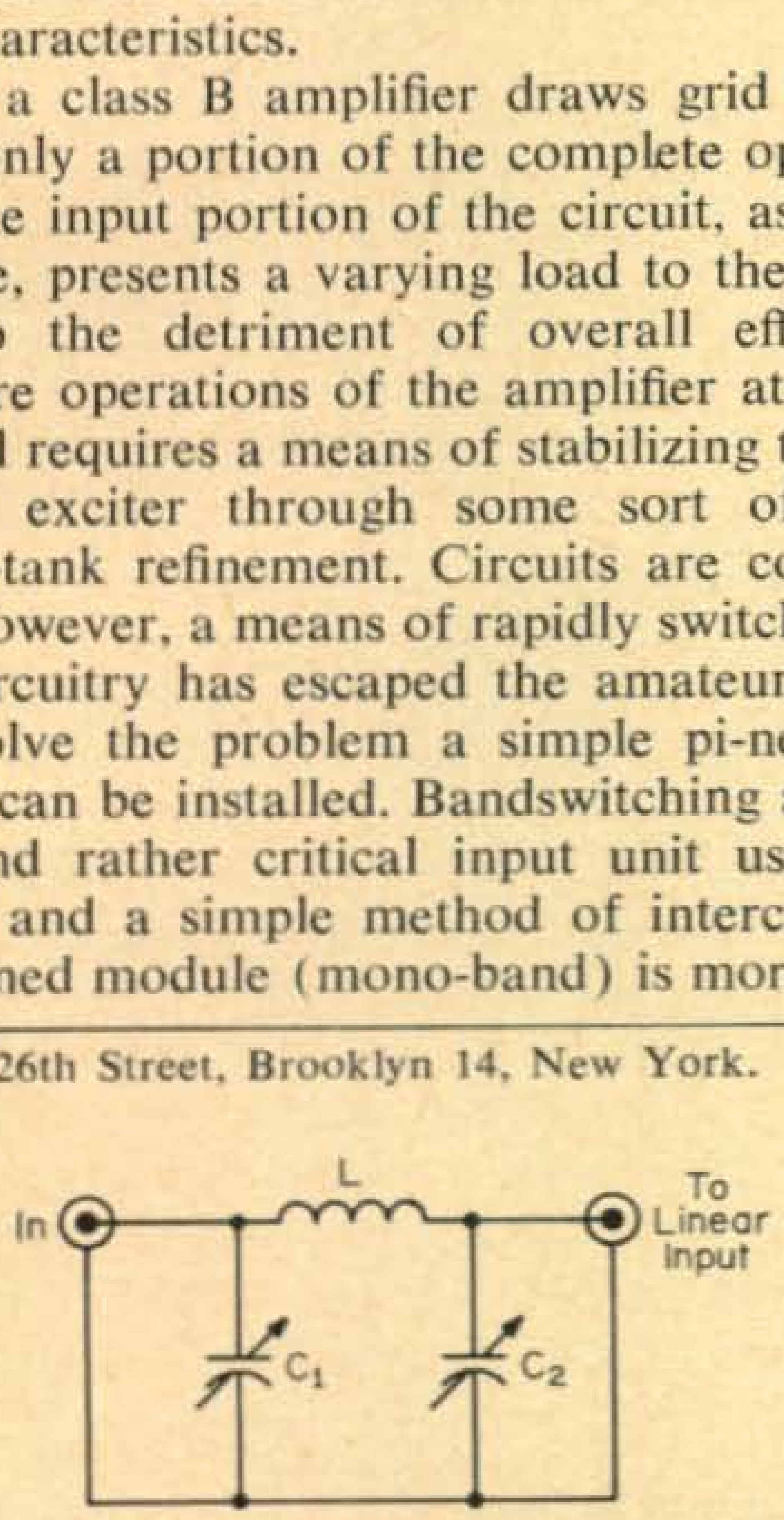
BY RONALD LUMACHI,*
WB2CQM

GROUNDED grid linear amplifiers generally present no extraordinary difficulties in construction. Circuitry is rather straightforward once a tube choice has been made. However, matching the exciter-transmitter to the constantly varying and unstabilized load of the cathode has been a problem of some importance. Owners of fixed output exciters are especially concerned with accurate and constant 50 ohm input characteristics.

Since a class B amplifier draws grid current during only a portion of the complete operating cycle, the input portion of the circuit, as a consequence, presents a varying load to the exciter stage to the detriment of overall efficiency. Therefore operations of the amplifier at its full potential requires a means of stabilizing the load for the exciter through some sort of tuned cathode-tank refinement. Circuits are commonplace; however, a means of rapidly switching the input circuitry has escaped the amateur.

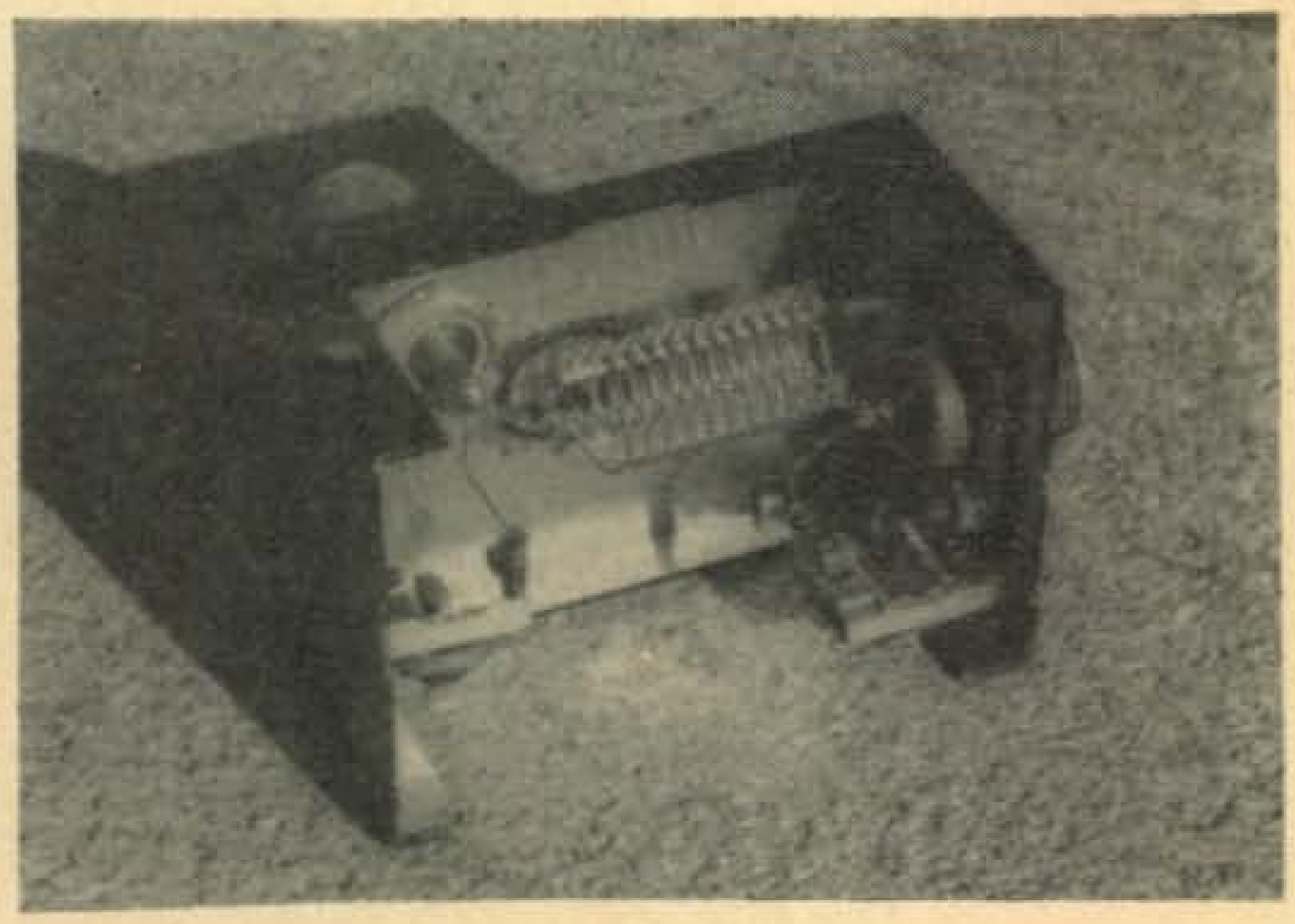
To solve the problem a simple pi-net input module can be installed. Bandswitching an elaborate and rather critical input unit usually is difficult and a simple method of interchanging a pre-tuned module (mono-band) is more favorable. By attaching a DOW-KEY*UHF panel mount (male) coaxial fitting at the output end of the pi-net module, the unit will mate perfectly to the SO-239 connector usually found at the input of a linear amplifier. Simply screw into place. Heretofore this rather esoteric unit was a "dead special" item. Its use for rapid band switching a small minibox module is truly a windfall for the amateur.

Once the individual modules have been pretuned for their individual band, they can be stored until needed for multiband linear amplifier operation. ■



Band	(L)Air Dux #	Turns	C_1	C_2
10	406	8	130	110
15	408	9	180	140
20	410	11	270	220
40	510	18	550	480
75	616	12	1000	850

Fig. 1—The input network is the conventional pi shown above. Both capacitors, as listed in the chart (in mmf), are compression type trimmers.



View of the interior of the 20 meter pi-network used to match the output of an s.s.b. exciter unit to the input of a grounded grid class B linear. The Dow Key connector used to mount the unit on the linear is on the left side of the Minibox and the input from the exciter is fed to the right hand connector.

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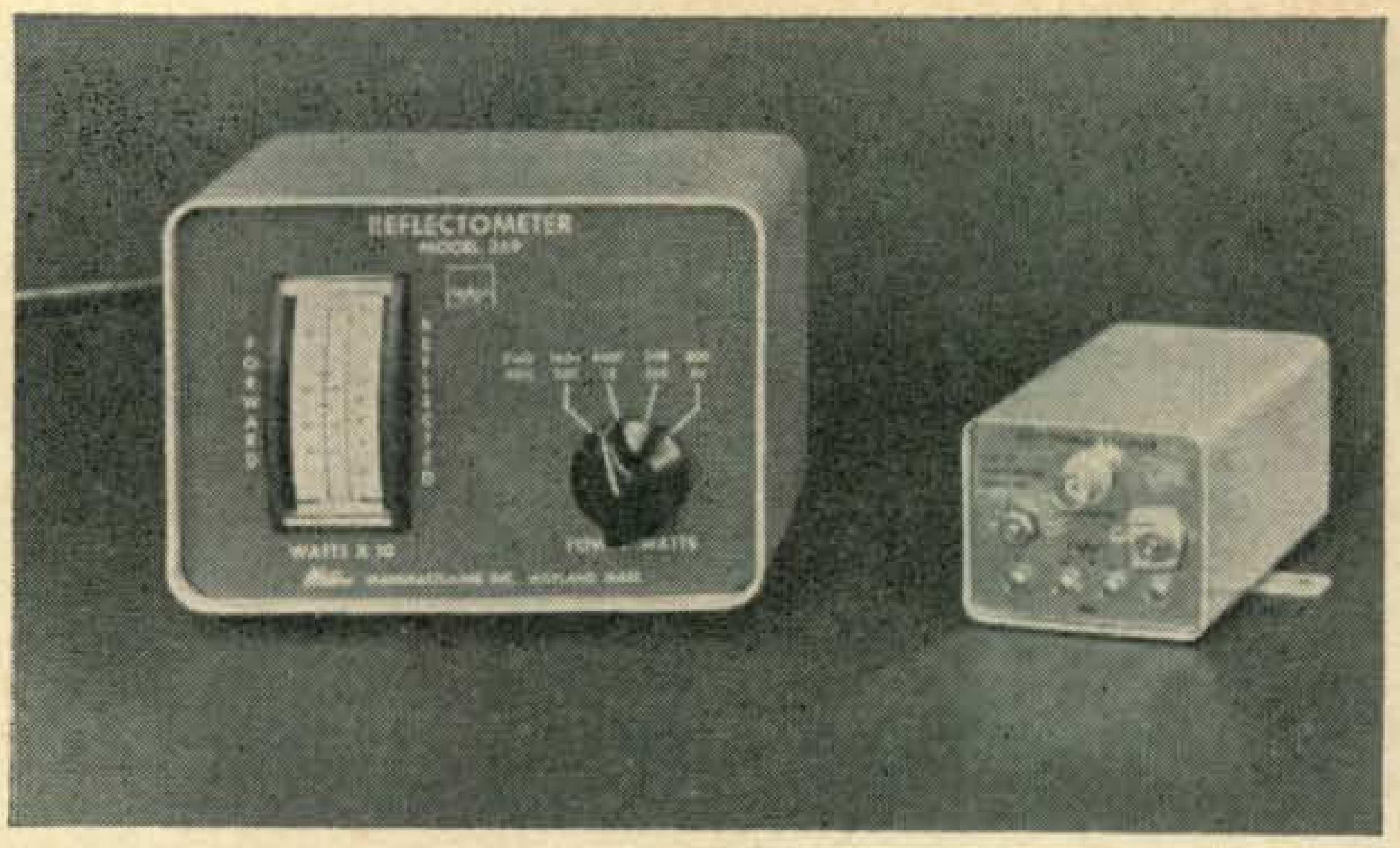
THE Datak Corporation recently expanded their line of over 2000 alphabet sheets and electronic marking sets. The new line is fully described in their 32 page catalog. Also included is information on project-A-type translucent colored letters and sheets, architectural symbols, drafting sheets and instanex, a new art medium. This should be interesting to all the home-brewers. For copies write to: Public Relations Dept., The Datak Corp., 85 Highland Ave., Passaic, New Jersey, or circle 72 on page 112.

The Waters Model 369 Reflectometer. The directional coupler is at the right.



CQ Reviews:

The Waters Model 369 Reflectometer

BY WILFRED M. SCHERER,* W2AEF

THE Waters Model 369 Reflectometer is an "in-line" device using dual indicators to simultaneously show both the forward and the reflected power on a transmission line *in watts* over a frequency range of 3.5-30 mc. It thus functions as a directional wattmeter by which the s.w.r. can be determined at the same time, making it useful to monitor the wattage output and the s.w.r. together. Also, in conjunction with a matched dummy load, it will serve as a wattmeter for checking transmitter performance.

Most of the reflectometer-type s.w.r. meters presently in use with amateur gear provide an indication of only *relative* power and you cannot monitor the output and the s.w.r. concurrently, only one function at a time being available for observation as selected by a switch.

Unlike some of the other devices, the Model 369 has an essentially flat response over it's frequency range and thus requires no readjustment of a sensitivity control whenever the operating frequency is changed, nor does it involve a calibration setting when an s.w.r. check is to be made.[1]

The Waters unit also has several meter ranges to more accurately read various power levels, particularly in connection with the reflected power as needed for better determining very low s.w.r.'s. These ranges are 0-200 and 0-1000 watts forward power; 0-20 and 0-200 watts reflected power. The job is designed for use with 50-53 ohm lines with which it's residual s.w.r. is rated at 1.06 or less.

The setup consists of two separate units: a directional coupler and an indicator box with the dual-reading meter. Two meter movements are used, physically arranged so that their scales and pointers can be seen directly alongside one another in a single edgewise-mounted type of meter case. Simultaneous observation of both scales is thus more readily made than with two separately located meters. A four-position switch selects different combinations of forward and reflected power ranges.

The directional coupler is equipped with BNC-type fittings[2] for installation directly in the transmission line. This may be done near the transmitter-output connector. The two units are connected together with a five-wire cable of which 10 feet are supplied[3] to enable the indicator to be placed at a convenient spot where it may be easily observed from the operating position.

Theory of Operation

The Waters Reflectometer functions as follows: The input and output terminals are joined by a single conductor which passes through the center of a toroid-wound coil. The conductor becomes the primary and the coil makes up the secondary of a current-transformer T_1. The transmission-line *current* then induces a voltage into the secondary to produce identical voltages across equal-value resistors R_2 and R_3; however, these voltages, which appear at B and C (with respect to ground), are *out of phase* by virtue of the "push-pull" configuration due to the grounded mid-connection. On the other hand, the transmission-line *voltage* is applied across identical-size capacitive dividers, C_2-C_3 and C_4-C_5, to provide equal *in-phase* voltages at A and D.

When the transmission line is terminated with a matched non-reactive load, resulting in a unity s.w.r., the settings for C_2 and C_4 (as initially made during production) also are such that the voltage at A equals that at B, but due to the polarity of the transformer connections, these voltages will be *out of phase* or of opposite polarity. This

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*Technical Director, *CQ*.

[1] The inherent design of the Model 369 is such that it is not feasible to have *both* a flat frequency *response* and a wide frequency *range* at the same time. As the frequency increases above the 30 mc limit, the coupling transformer (see fig. 1) becomes resonant, resulting in calibration inaccuracies.

[2] Adapters are available for mating to PL-259 connectors.

[3] Spade lugs are also supplied for installation by the customer at the ends of the leads after the cable has been cut to desired length.

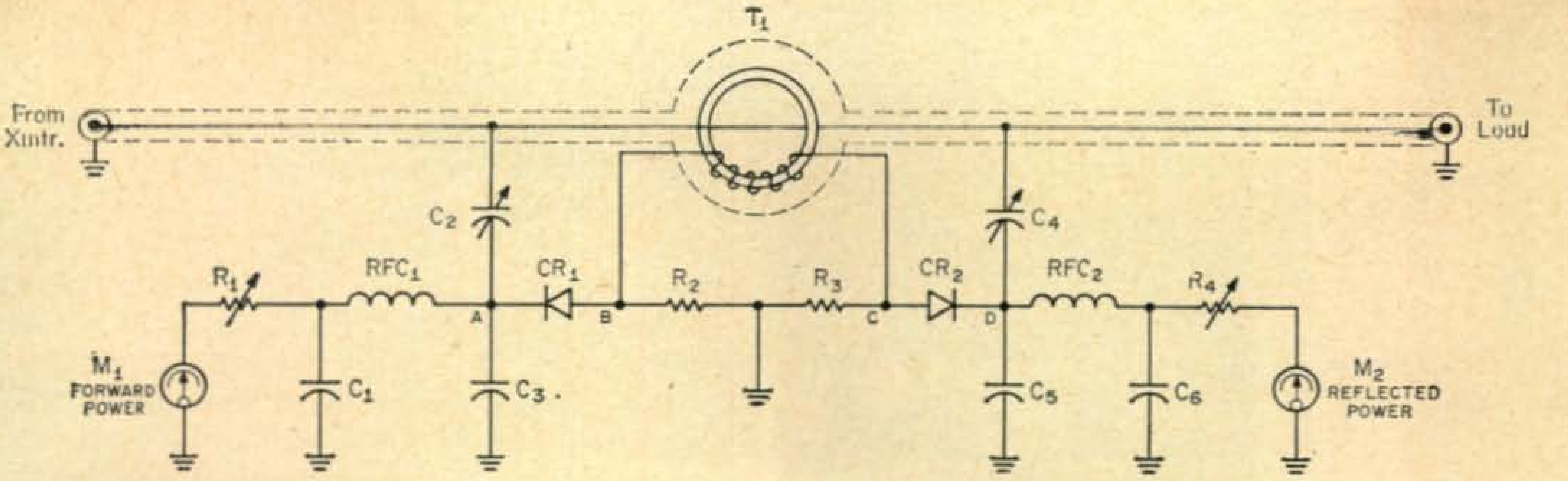


Fig. 1—Circuitry of the Waters Model 369 Reflectometer. Theory of operation is explained in the text.

causes a potential difference between A and B which is then detected by CR_1 to actuate the forward-power meter M_1.

Similarly, there are equal voltages at C and D, but these will be *in phase* or of the same polarity, resulting in zero voltages across the detector CR_2. The reflected-power, meter, M_2, will remain at zero.

When the s.w.r. on the transmission line is other than unity, the voltages at A and D will be proportional to the vector sum of the forward and reflected *voltages* on the line, and the voltages at B and C will depend on the vector sum of the forward and reflected *currents*.

Since the instrument was initially balanced for unity s.w.r., any reflected component, due to higher s.w.r., will unbalance the setup and cause the meters to read according to the resulting potential changes that then occur across their associated diode detectors.

As the frequency increases, both the induced voltage and the reactance of T_1 secondary rise in direct proportion to one another, so the secondary current and, consequently, the voltages at B and C are unaffected by frequency changes. Neither are the voltages at A and D influenced by the frequency, because the ratio of the capacitive reactances of dividers C_2-C_3 and C_4-C_5 remains constant. These factors, together with proper transformer design and related component selection, thus make the accuracy of the Model 369 relatively independent of frequency throughout the range for which it has been devised.

RFC_1, RFC_2, C_1, C_6 provide r.f. filtering for the meters. Power readings are calibrated with R_1 and R_4.

Using The Reflectometer

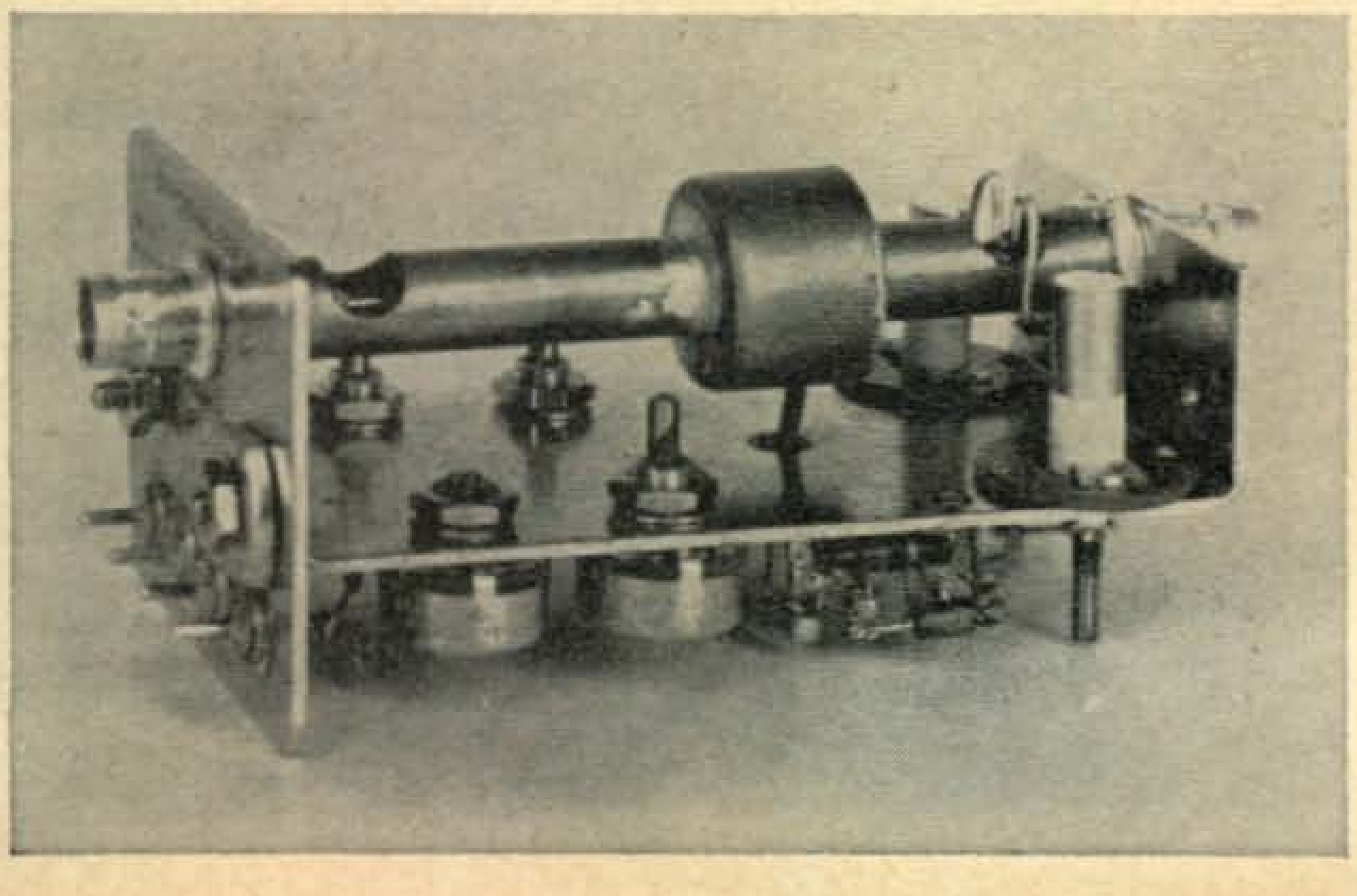
In use the power delivered to the load is the indicated forward power *minus* the reflected-power reading. When the load is matched (50-ohm resistive) there is no reflected power, so all the transmitter power is transferred to the load. When the load is mismatched, some of the transmitter power is reflected back toward the transmitter and cancels an equivalent portion of the forward power.

The relation between the forward and reflected power readings depends on the degree of mismatch and thus is indicative of the s.w.r. This can be calculated by formula, but it need not be so done with the Model 369, which is supplied with a chart from which you can quickly find the s.w.r. for specific related forward and reflected powers.

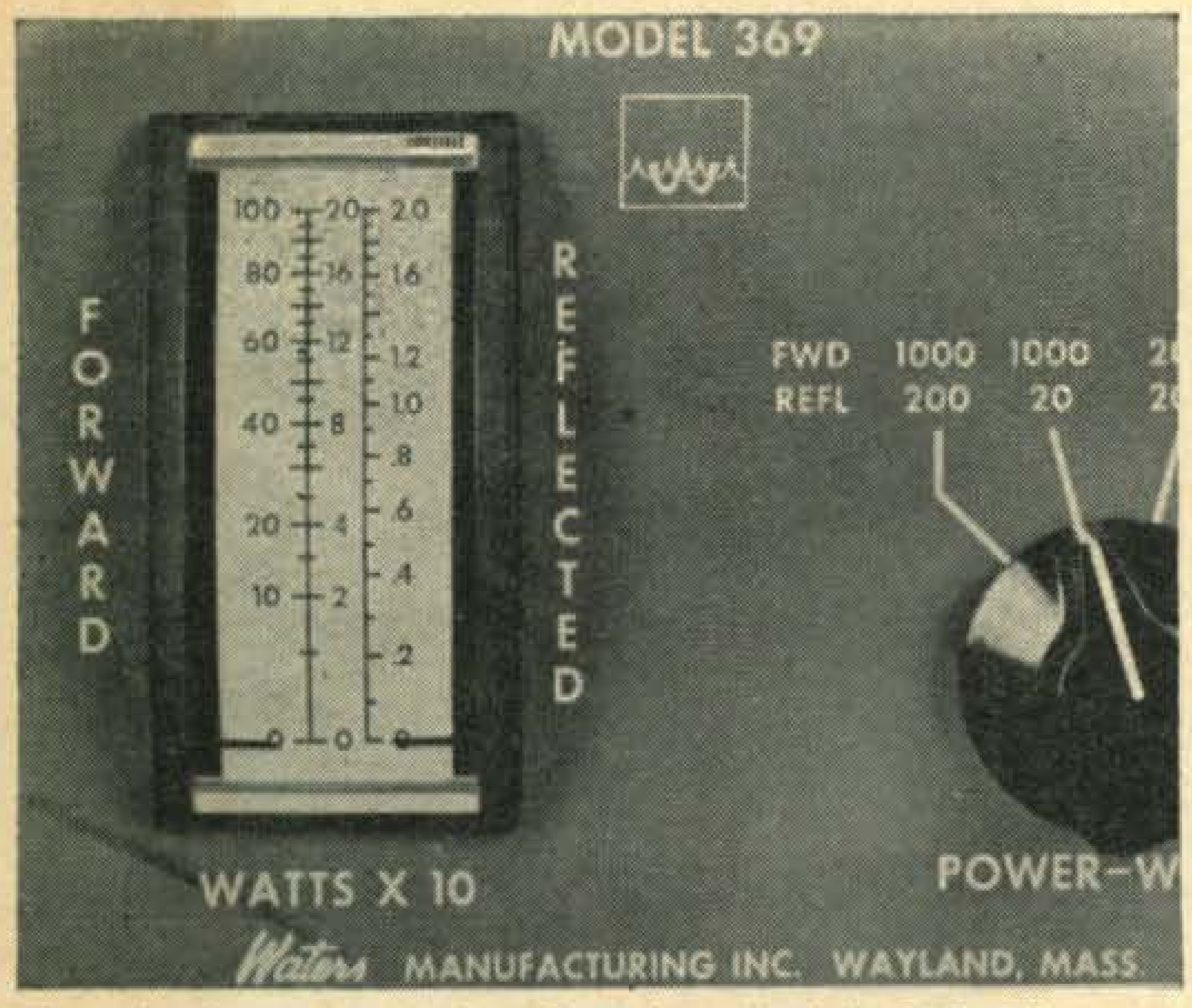
The s.w.r. also can be obtained from the percentage of the forward power that the reflected power represents, so another chart is furnished showing the s.w.r. on this basis. Since the object is to obtain as low an s.w.r. as possible, percentages for a few s.w.r.'s in the area of most interest may be easily kept in mind. For instance: a reflected-power reading equivalent to 10% of the forward power indicates an s.w.r. of just under 2:1, a 5% relation indicates slightly over 1.5:1, and of course 0% is found with a 1:1 ratio.

Performance

The accuracy of power readings with the Model 369 is rated at ±10% of full scale. It is also stated that the reflectometer will read transmitter power accurately only if the load presents close to a 1:1 s.w.r. With a unity s.w.r. the accuracy was found to be within



Interior view of the directional coupler for the Model 369. The current-transformer is enclosed in a copper shield along with the transmission-line section across the top of the unit.



The dual meter scales for the Model 369. The two pointers may be seen at the zero point.

5% over the rated frequency and within 10% with an s.w.r. of 2:1.

It often will be found with s.w.r. indicators that when the s.w.r. is greater than 1:1, changing the location of the instrument in the line produces a different s.w.r. reading than before. The extent to which this occurs is dependent on the "directivity" of such devices which seldom is perfect. Evidently the Waters unit has excellent directivity characteristics, inasmuch as it was found less susceptible to such errors than customarily experienced. In any case, where a high s.w.r. exists, the best accuracy will be had when the length of the line between the coupler and the load is a half wave at the operating frequency.

When transmitter-output performance is to be checked under steady-state conditions (tune-up), it must be kept in mind that the d.c. input to the p.a. should not exceed the legal limit of 1000 watts. If you have a p.a. capable of higher d.c. input, you'll have to use a dummy load. This would be desirable anyway to eliminate unnecessary interference. In such cases the output power might exceed the 1000 watt range of the reflectometer, but higher output still may be determined safely (up to 2 kw) as follows:

Tune up the equipment in the normal manner for maximum performance while the 1000-watt range is in use. The meter pointer may go off scale, but the job will handle the extra power. Then back down on the r.f. drive until 1000 watts output is indicated. At this point note the input to the p.a. and find the efficiency from $\%_{eff} = P_{out} \div P_{in} \times 100$. The output with higher drive and power input can then be found from $P_{out} = \%_{eff} \times$ the new power input.

With normal s.s.b. modulation and without excessive a.l.c., the meter will swing up to about one-third the actual peak-power output, so even with a 2 kw p.e.p. input the reading will be on scale, kicking up to about 500 watts (assuming normal transmitter efficiencies).

For the die-hard who insists on a higher range than provided,[1] there is the following solution, but it is one that will void the manufacturer's warranty: Remove the case from the coupler, reinstall the coupler in the line and adjust the transmitter for 1000 watts output. Then, viewing the coupler from the transmitter end, back down on the left rear calibrating control until 500 watts are indicated. You'll now have a 2000-watt forward range the numerical calibrations of which should be doubled. If the control cannot be backed down far enough, the size of the resistor connected in series with it will have to be reduced also.

The meter scales are relatively large and are easily observed simultaneously during operation. The size of the indicator box is 4¼" × 5½" × 3¾" (H.W.D.) and the coupler is 4" × 2" × 2-7/16".

The Waters Model 369 Reflectometer is priced at $115. Adapters for BNC to PL-259 connectors are $2.60 (Waters part No. EL-A-2903-11). The device is a product of Waters Manufacturing, Inc., Wayland, Mass.—*W2AEF*

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[1] The particular ranges have been selected by the manufacturer for best accuracy and convenience with either an exciter or a p.a. operating within the legal steady-power limit.

New Amateur Product

Triplett 630-APLK v.o.m.

Triplett Electrical Instrument Company, Bluffton, Ohio, has introduced a new portable volt-ohm-milliammeter, Model 630-APLK, with a transistorized switching circuit that guards against accidental burn-outs, provides overload protection and virtually eliminates bent pointers, burned out resistors, shunts and coils. Featuring high sensitivity of 20,000 ohms per volt d.c. and 5,000 ohms per volt a.c., the v.o.m. has an accuracy of ±1½% d.c. and ±3 a.c. guaranteed in horizontal position. The unit is usable with frequencies through 500 kc, and sells for $95.00. For more information either write direct or circle 74 on page 112.

You say your taxes were raised?

You missed three payments on your Jaguar XK-E?

You had to turn in your Playboy Club Key?

Your salary was cut?

You say the F.C.C. has expressed interest in your four different calls?

You say food is so expensive it's cheaper to eat money?

You say you invited your boss to dinner and during the soup course the finance company repossessed your furniture?

You say your XYL backed the family car out of the garage after you backed it in the night before, and now you can't get to the Newsstand to get your monthly copy of CQ?

HOLD IT!!

While we are in no position to alter the tax structure, give you a raise, or sway the F.C.C., we *can* save you a pile of cash on CQ! So drop that anchor, pick up a pen and dash off a CQ subscription right away!

1 yr.	**I PAY ONLY $ 5.00**	a savings of $ 4.00
2 yrs.	**I PAY ONLY $ 9.00**	a savings of $ 9.00
3 yrs.	**I PAY ONLY $13.00**	a savings of $14.00

And now with all this newfound money at your disposal, you can begin to really live again!

DX

BY URB LE JEUNE,* W2DEC

Northern California DX Club DX Bulletins

Once again W6TI has been reactivated and can be heard weekly transmitting DX bulletins. The station is under the able direction of prominent DXer, QSLer, and personality, Bob Vallio, W6RGG. These bulletins can be heard on 14,002 kc according to the following schedule:

PRIMARY TIME: Sunday, 1600 GMT (Sunday 0800 PST).

SECONDARY TIME: Monday, 0100 GMT (Sunday, 1700 PST).

Here and There

BV1 Taiwan: The following note is from Harvard, K7KPM: "The Chinese (Taiwan, that is) Government has prohibited amateur operation by foreign (American) nationals. As a result all stations with the prefix of BV1US are now off the air. I have the logs for BV1USA and will soon have the logs for BV1USF. I have plenty of BV1USA QSLs left, SAE appreciated."

FH8 Comoros: FH8CD active on 14 mc c.w./s.s.b. around 1630 GMT, usually 14112 or 14140 kc.

GR Rockall: Rockall has been cancelled until 1967.

GW Wales: GW3DZJ, Frank, will be very active during the Wales activity weekend October 22 and 23. Look for him on 14120/230 and 21390/420. *(Tnx K1YZW).*

JW Spitzbergen: JW is the new prefix for Spitzbergen. JW3NI is the only resident station.

JX Jan Mayen: JX is the new prefix for Jan Mayen. JX2IK and JX5CI are active on 14 mc c.w. *(Tnx VERON).*

TA Turkey: TA2BK often active on 14005/15 kc. QSL via DJ2PJ.

VP5 Turks Island: VP5RB, Bob, listens daily at the following times on specified frequencies for stations looking for contacts with Grand Turk: 14,132 kc (2130 GMT); 14,232 kc (2200 GMT); 21,332 kc (2300 GMT); 28,832 kc (2330 GMT). *(Tnx VP5RB).*

VP8 South Georgia: VP8AM and VP8HY are active on 14 mc c.w. *(Tnx VERON).*

VS5 Bruney: Jack, VS5JC, very active almost daily between 1400 and 1500 GMT on 14025/35 kc c.w. *(Tnx Puerto Rican DXer).*

YA Afghanistan: YA1DAN very active from Kabul looking for W/K contacts on 14210/240 kc daily after 0200 GMT. *(Tnx Puerto Rican DXer).*

The following certificates were issued during the period from June 6, 1966 to August 5, 1966:

CW-PHONE WAZ

2296	G2CCD	2312	W0GQL
2297	KR6UP	2313	DJ5DA
2298	K7BJE	2314	K2YTC
2299	W0OVQ	2315	UT5EH
2300	DL4LF	2316	JA1GTF
2301	W9IGW	2317	DJ6HJ
2302	VE3AAZ	2318	OK1ABP
2303	DJ7CX	2319	OE2EGL
2304	W4EEU	2320	OK1AAW
2305	W7MH	2321	OK2KJU
2306	W4ORT	2322	DL7CT
2307	K4SCT	2323	W0RZU
2308	I1ATO	2324	DJ3GY
2309	OK2BCI	2325	EP2BQ
2310	LU5AH	2326	JA1FDU
2311	LA7WI	2327	VE8BB

ALL-PHONE WAZ

339	TF3EA	340	UA9HA

TWO-WAY SSB WAZ

404	SM5RK	409	EA4GZ
405	TF3EA	410	W2GKZ
406	SM5CZM	411	G3WW
407	W2QKJ	412	K6BPR
408	K2YLM	413	DJ7ZG

CW WPX

730	JA7AD	734	OK2DB
731	OK1BB	735	OK1ABP
732	UW3BX	736	W8TRN
733	OK3OM	737	PY2BGL

PHONE WPX

131	LU3BU

SSB WPX

247	KP4RK	249	UW9AF
248	UA4SS		

MIXED WPX

122	DL4KD	123	PA0SNG

100 TWO-WAY SSB

490	W6NAT

200 TWO-WAY SSB

135	ZS6LW

YK Syria: Rasheed, YK1AA, active almost daily at 0300 GMT on 14220 kc. *(Tnx Puerto Rican DXer).*

ZA Albania: According to a report in LIDXA, ZA1BB, who has appeared on 14050 at 1300 GMT and 14079 at 0000 GMT, is legitimate. The report by OK1ADM also says that QSLs go to Radio Tirana and will be sent in November.

ZD7 St. Helena: Gerry, ex-ZD7BW, passes along the following: "I am being flooded with requests for QSLs for ZD7BW operation on 75 starting last December. The call was licensed from August 7th, 1963 to November 23rd, 1963 and, therefore, this recent operation is that of some joker. If these people had heard what a struggle I had on 75 s.s.b. from St. Helena (K6ERV excepted) they would have realized that all these 5/9s were a bit fishy."

4S7 Ceylon: Paddy, 4S7PB, occasionally active from Colombo around 14225 kc at 0300 GMT. *(Tnx Puerto Rican DXer).*

9U5 Burundi: 9G1FQ will operate from 9U5 in November. *(Tnx NCDXC).*

[*Continued on page 102*]

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*Box 35, Hazlet, New Jersey 07730.

Propagation

BY GEORGE JACOBS,* W3ASK

THE 1966 *CQ* World Wide DX Contest will be held on the following dates[1]: Phone Section: 0000 GMT October 22—2400 GMT October 23, C.w. Section: 0000 GMT November 26—2400 GMT November 27.

Continuing the practice of the past fifteen years, this month's PROPAGATION column will be devoted to a special forecast for use during the 1966 contest. Last year's forecast missed on the phone section by being too pessimistic, but hit the c.w. period pretty much on the nose. For those readers interested in statistics, these forecasts have been "highly accurate" 22 times; "fairly accurate" 5 times, and missed the mark only 3 times, during the past fifteen years!

Sunspot Cycle

The new sunspot cycle continues to rise, but sunspot number of 56 for July, 1966. This results at a relatively slow pace. The Swiss Federal Solar Observatory at Zurich reports a monthly mean in a smoothed sunspot number of 27, centered on January, 1966. A smoothed sunspot number of 55 is forecast for October, and 58 for November, 1966. This is approximately the same level of solar activity that last occurred during 1961, and before that, during the fall of 1955.

General Forecast

Barring any sudden radio storms developing during the contest periods (check the "Last Minute Forecast" appearing at the beginning of this column), conditions during the 1966 contest are expected to be *considerably better* than they have been during any previous contest period since 1960. The following is a band-by-band summary of general propagation conditions that are likely to occur during the 1966 contest:

10 Meters—As a result of increasing solar activity, some fairly good DX openings to many areas of the world are forecast for 10 meters. The band is expected to open a few hours after sunrise, and remain open to one area of the world or another until the late afternoon hours. Openings to Europe and those in a generally easterly direction are expected to peak an hour or two before noon, while those to South America and in a generally southerly direction are forecast to peak an hour or two after noon. Optimum conditions to the Far East, Australasia, Southeast Asia, etc. are expected during the late afternoon hours.

15 Meters—Excellent DX propagation conditions are predicted for most of the daylight hours, and into the early evening hours for openings in some directions. Strong signal levels are forecast, with good openings expected to all areas of the world.

20 Meters—Good DX propagation conditions are forecast to almost all areas of the world from sunrise through the late evening hours, and throughout the hours of darkness in some directions. Conditions are expected to peak shortly after sunrise for an hour or two, and again during the late afternoon and early evening hours.

40 Meters—The first DX openings are expected during the late afternoon hours, becoming more numerous during the hours of darkness. The band is forecast to remain open to one area of the world or another until shortly after sunrise. Fairly good DX openings to most areas of the world should be possible, with signals often exceptionally strong.

80 Meters—While not expected to be as good as 40 meters for DX propagation conditions, some fairly good open-

LAST MINUTE FORECAST

Day-to-Day Conditions and Quality for October

	Forecast Rating & Quality			
Days	(4)	(3)	(2)	(1)
Above Normal: **9, 15, 17, 20, 24, 27**	A	A-B	B-C	C
Normal: **1, 3-6, 8, 10, 13-14, 16, 18-19, 21, 23, 25-26, 28-29, 31**	A-B	B-C	C-D	D-E
Below Normal: **2, 7, 11, 22, 30**	C	C-D	D	E
Disturbed: **12**	D	D-E	E	E

HOW TO USE THESE CHARTS

The following is an explanation of the symbols shown above and instructions for the use of the *CQ* propagation predictions:

1—Enter Propagation Charts on following pages under appropriate band and distance or geographical area columns. Read predicted times of band openings at intersection of both columns.

2—Following each predicted time of band opening is a forecast rating which indicates the relative number of days the band is expected to open during each month of the forecast period. The higher the rating, the more frequent the opening, as follows: (4) band open more than 22 days each month; (3) between 14 and 22 days; (2) between 8 and 13 days; (1) less than 7 days.

3—With the forecast rating noted above, start with the numbers in parentheses at the top of the "Last Minute Forecast" appearing above. Read down the table for a day-to-day forecast of propagation conditions in terms of Above Normal (WWV rating higher than 6); Normal (WWV rating 5-6); Below Normal (WWV rating 4); Disturbed (WWV rating less than 4). The letter symbols (A-E) describe reception conditions (signal quality, noise and fading levels) expected for each day of the month and have the following meanings: A—excellent opening with strong, steady signals; B—good opening, moderately strong signals, little fading and noise; C—fair opening, signals fluctuating between moderately strong and weak; D—poor opening, signals generally weak with considerable fading and noise; E—poor opening, or none at all.

4—This month's DX Propagation Charts are based upon a transmitter power of 250 watts c.w.; 500 watts s.s.b., or 1000 watts d.s.b. into a dipole antenna a quarter-wave above ground on 160 and 80 meters, a half-wave above ground on 40 and 20 meters, and a wave-length above ground on 15 and 10 meters. For each 10 db gain above these reference levels, reception quality shown in the "Last Minute Forecast" will improve by one level; for each 10 db loss, reception will become poorer by one level.

5—Local Standard Time for these predictions is based on the 24-hour system.

6—The Eastern USA chart can be used in the 1, 2, 3, 4, 8, KP4, KG4 and KV4 amateur call areas; The Central USA Chart in the 5, 9 and 0 areas, and the Western USA Chart in the 6 and 7 areas. The Charts are valid through Nov. 30, 1966, and are prepared from basic propagation data published monthly by the Institute For Telecommunication Sciences And Aeronomy of the U.S. Dept. of Commerce, Boulder, Colorado.

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*11307 Clara Street, Silver Spring, Md. 20902.

[1] See page 49 of *CQ*, September, 1966 for complete contest information.

ings are forecast to some areas of the world during the hours of darkness. Conditions are expected to peak shortly before sunrise, during the pre-dawn period.

160 Meters—At the present level of solar activity, DX openings to some areas of the world may be possible during the hours of darkness and the pre-dawn period. Because of ionospheric absorption and the low power used on this band, signals at best, are expected to be weak and noisy.

For a more detailed circuit-by-circuit forecast please refer to the special contest *DX Propagation Charts* appearing on the following pages. Instructions for the proper use of these *Charts* are given in the box following the "Last Minute Forecast" at the beginning of this column.

Contest Work Plans

The *DX Propagation Charts* on the following pages show the times that each amateur band from 10 through 160 meters are expected to open from the United States to all other areas of the world. The information contained in the *Charts* can be easily reorganized into operational work plans, or schedules, to serve as a guide during the contest periods. Experience has shown that plans of this type have been useful in helping to pile up a large number of points with a minimum of wasted time or effort. As an example, data appearing in the Charts has been used to make the following 20 meter work-plan, which shows the optimum times for working various areas of the world on this band. An Eastern USA QTH has been chosen for this example, but similar schedules can be devised for other QTHs and other bands.

Sample 20 Meter Operating Schedule for Eastern USA

Time EST	*Areas to which openings should be optimum*
00-03	Not much. Some northern and central South Americans, and perhaps Antarctica. Good time for some sleep.
03-06	Not much. Good time for some sleep. Some weak openings to the south.
06-09	Excellent period. Good openings from all directions: Europe, North Africa, eastern Mediterranean, Far East and Asia, Guam & Pacific area, Australasia, South America.
09-12	Good period. Openings to most of Europe, South America, Guam & Pacific.
12-15	Fair period. Openings to most of Europe, eastern Mediterranean, some African openings, some openings to northern areas of South America. Take some time out for lunch.
15-18	Western and central Europe, Africa, eastern Mediterranean, north and central areas of South America. Openings should pick up during this period.
18-21	Good period. Openings to most of Africa and South America. Some Far East and Asiatic openings. Fairly good openings to the Pacific Islands and Australasia and Antarctica.
21-00	Fairly good period. Openings to the Pacific Islands and Australasia, South America, the Far East and Antarctica.

The following is a typical *multi-band* operational schedule based on a Western USA QTH. The schedule shows the times and bands when propagation conditions are expected to be optimum to various parts of the world.

Sample Multi-Band Work-Plan for Western USA

Time PST	*Optimum Band*	*Areas to which band expected to be open*
00-03	40 M.	Far East, Asia, Pacific Islands, New Zealand and Australasia, South America, Antarctica.
03-06	40 M.	Same.
06-09	20 M.	Good period with openings to many areas. Europe, eastern Mediterranean, Far East, Asia, Pacific Islands and New Zealand, Australasia, most of South America.
09-12	20 M.	Europe, eastern Mediterranean, Africa starting to open, Pacific Islands and New Zealand, Australasia, northern and central South America.
12-15	15 M.	Africa, a few Europeans, Far East, Asia, Pacific Islands and New Zealand, Australasia, South America, Antarctica.
15-18	20 M.	Western and central Europe, Africa with good openings, South America, Pacific Islands and New Zealand, Australasia.
18-21	20 M.	Africa and eastern Mediterranean, a few European, Far East, Asia, peak conditions for Pacific Islands and New Zealand, Australasia and Antarctica, many parts of South America.
21-00	20 M.	Poor period on all bands, good time to catch up on some sleep. Some openings to Far East, Pacific Islands and New Zealand, Australasia, southern South America and Antarctica.

Radio Storms

The predictions in this column are based on normal propagation conditions. If conditions should be above normal during the contest periods, DX openings on 10, 15 and 20 meters are likely to be somewhat better than predicted. On the other hand, if a radio storm should develop during the contest, with below normal or disturbed conditions, fewer openings will take place on 10, 15 and 20 meters. During radio storms, conditions on 40, 80 and 160 meters are likely to become erratic, and under certain conditions may be poorer than shown in the forecast, while under other conditions they may actually improve.

If a radio storm should develop during the contest, circuits passing through or near the auroral zones will probably become weak, fade considerably, or may even black out entirely, depending on the severity of the storm. On the other hand, often during such storms, conditions on north-south paths may improve. During a radio storm, concentrate on working east-west openings during the daylight hours, and north-south openings during the evening and early morning hours. A "Last Minute Forecast" for the Phone section of the Contest, made at press time (early September), appearing at the beginning of this column. A similar forecast for the C.w. section will appear in next month's column.

Up-To-The-Minute Forecasts

Check WWV for the latest information on actual propagation conditions during the contest. WWV broadcasts propagation information on 2.5, 10, 15, 20 and 25 mc twelve times every hour. The data is transmitted at 4½ minutes past the hour, and is repeated every five minutes thereafter. Given in Morse Code, the transmissions consist of the letter N, W, or U, followed by a number ranging between 1 and 9. The letter designations apply to propagation conditions as of the time of broadcast, as follows:

W—Ionospheric disturbance in progress or expected.
U—Conditions unstable, signals subject to fading and noise.
N—Normal conditions, no warning necessary.

The number designations apply to propagation conditions forecast for the following 6 hours, as follows:

1—Impossible; 2—very poor; 3—poor; 4—fair-to-poor; 5—fair; 6—fair-to-good; 7—good; 8—very good; 9—excellent.

If, for example, propagation conditions are normal at the time of forecast, but are expected to become "poor" during the next six hours, the announcement would be broadcast as N3 in slow Morse Code.

Up-to-the-minute propagation data can also be obtained by telephone from the ESSA Radio Warning Centers at Fort Belvoir, Virginia (for the North Atlantic area), and Anchorage, Alaska (for the North Pacific area). The telephone numbers for this service at Fort Belvoir is Area Code 703-780-1444 or 780-1436, and at Anchorage it is Area Code 907-753-2211 or 753-7210. Information on current radio propagation conditions can be obtained from Fort Belvoir 24-hours a day, and from Anchorage from between 0800 and 1700 Alaskan Standard Time.

Post Mortem

More radio amateur activity takes place in more parts of the world during the *CQ* World Wide DX Contest than probably during any other time.

For this reason, the contest offers an excellent opportunity to check out the accuracy of the *CQ* predictions. Information reported during previous contests have contributed considerably to improving these forecasts from year-to-year. Any comments or observations concerning the accuracy, or inaccuracy of this month's special contest would be appreciated. Comments can be sent to W3ASK, the Editor of this column.

C.w. Contest Forecast

The *Propagation Charts* appearing in this month's column are valid for *both* the phone and c.w. periods of the contest. *Be sure to retain the Charts for use during next month's c.w. period.* The *Charts* appearing in next month's column will contain Short-Skip forecasts for November and December, 1966. Short-Skip information for October appeared in last month's column. Conditions look normal or better for the contest period.

Good luck in the Contest!

73, George, W3ASK

CQ DX Propagation Charts

OCTOBER & NOVEMBER, 1966

Time Zone: EST (24 Hour Time)

Eastern USA To:

	10/15 Meters	*20 Meters*	*40 Meters*	*80/160 Meters*
Western & Central Europe & North Africa	09-10 (1)* 10-11 (2)* 11-13 (1)* 07-08 (1) 08-09 (3) 09-11 (4) 11-12 (3) 12-13 (2) 13-15 (1)	05-07 (1) 07-09 (4) 09-12 (3) 12-15 (4) 15-17 (3) 17-19 (2) 19-21 (1)	16-17 (1) 17-18 (2) 18-21 (3) 21-01 (4) 01-02 (3) 02-03 (2) 03-04 (1)	19-21 (1) 21-23 (2) 23-01 (3) 01-02 (2) 02-03 (1) 00-02 (1)†
Northern Europe & European USSR	08-11 (1)* 07-08 (1) 08-09 (3) 09-10 (2) 10-12 (1)	05-07 (1) 07-09 (3) 09-11 (2) 11-13 (3) 13-14 (2) 14-16 (1)	17-19 (1) 19-21 (2) 21-02 (1) 02-03 (2) 03-04 (1)	19-01 (1) 21-01 (1)†
Eastern Mediterranean	08-09 (1)* 09-11 (2)* 11-12 (1)* 07-08 (1) 08-10 (3) 10-12 (2) 12-13 (1)	05-07 (1) 07-09 (2) 09-11 (1) 11-13 (2) 13-16 (3) 16-20 (2) 20-01 (1)	19-21 (1) 21-23 (2) 23-00 (1)	20-23 (1)
West Africa	08-10 (1)* 10-14 (2) 14-16 (1)* 06-08 (1) 08-11 (2) 11-12 (3) 12-15 (4) 15-16 (3) 16-17 (2) 17-18 (	03-07 (2) 07-13 (1) 13-15 (2) 15-17 (4) 17-19 (3) 19-22 (2) 22-01 (1)	18-22 (1) 22-00 (2) 00-02 (3) 02-03 (2) 03-04 (1)	22-02 (1)
East & Central Africa	12-15 (1)* 07-11 (1) 11-13 (2) 13-15 (3) 15-17 (2) 17-18 (1)	05-14 (1) 14-16 (2) 16-18 (3) 18-23 (2) 23-01 (1)	21-23 (1) 23-01 (2) 01-02 (1)	23-01 (1)
South Africa	08-09 (1)* 09-11 (2)* 11-14 (1)* 06-10 (1) 10-12 (2) 12-15 (3) 15-16 (2) 16-18 (1)	07-14 (1) 14-15 (2) 15-17 (3) 17-20 (2) 20-22 (1) 22-01 (2) 01-03 (1)	18-20 (1) 20-22 (2) 22-00 (1)	20-22 (1)
Central Asia	07-10 (1) 17-20 (1)	06-07 (1) 07-09 (2) 09-11 (1) 19-22 (1)	18-20 (1) 05-07 (1)	*Nil*
Southeast Asia	08-12 (1) 18-20 (1)	06-07 (1) 07-09 (2) 09-15 (1) 18-21 (1)	05-07 (1) 17-19 (1)	*Nil*
Far East	07-09 (1) 16-17 (1) 17-19 (2) 19-20 (1)	06-07 (1) 07-09 (2) 09-11 (1) 16-19 (1) 19-22 (2) 22-23 (1)	05-09 (1)	*Nil*
Guam & Pacific Islands	11-12 (1)* 12-14 (2)* 14-17 (1)* 11-15 (1) 15-16 (2) 16-17 (4) 17-19 (3) 19-20 (2) 20-21 (1)	05-07 (1) 07-09 (3) 09-11 (2) 11-18 (1) 18-19 (2) 19-21 (3) 21-22 (2) 22-00 (1)	00-03 (1) 03-07 (3) 07-09 (1)	03-04 (1) 04-07 (2) 07-08 (1) 05-07 (1)†
Australia & New Zealand	14-17 (1)* 07-09 (1) 09-11 (2) 11-15 (1) 15-17 (2) 17-19 (3) 19-20 (2) 20-22 (1)	06-07 (1) 07-09 (2) 09-12 (1) 12-14 (2) 14-17 (1) 17-19 (2) 19-21 (3) 21-00 (2) 00-03 (1)	02-04 (1) 04-07 (2) 07-09 (1)	04-05 (1) 05-07 (2) 07-08 (1) 05-07 (1)†
Northern & Central South America	07-09 (1)* 09-13 (2)* 13-17 (3)* 17-18 (1)* 06-08 (1) 08-10 (3) 10-13 (2) 13-15 (3) 15-17 (4) 17-18 (3) 18-19 (2) 19-20 (1)	06-07 (2) 07-09 (4) 09-11 (3) 11-15 (2) 15-17 (3) 17-20 (4) 20-00 (3) 00-02 (2) 02-06 (1)	18-19 (1) 19-21 (2) 21-03 (3) 03-06 (1)	19-21 (1) 21-03 (2) 03-05 (1) 01-04 (1)†

*Predicted 10 meter openings, all others in column are 15 meter openings.

†Predicted 160 meter openings, all others in column are 80 meter openings.

Southern Brazil, Argentina, Chile & Uruguay	08-10 (1)* 10-13 (2)* 13-15 (3)* 15-16 (2)* 16-18 (1)* 07-08 (1) 08-10 (2) 10-13 (1) 13-15 (2) 15-17 (4) 17-18 (2) 18-20 (1)	07-09 (2) 09-15 (1) 15-17 (2) 17-19 (4) 19-20 (3) 20-02 (2) 02-07 (1)	19-23 (1) 23-04 (2) 04-06 (1)	23-04 (1)
McMurdo Sound, Antarctica	08-10 (1)* 14-17 (1)* 07-08 (1) 08-10 (2) 10-15 (1) 15-17 (2) 17-19 (1)	14-17 (1) 17-20 (2) 20-22 (3) 22-02 (2) 02-07 (1) 07-09 (2) 09-11 (1)	00-06 (1)	*Nil*

Time Zones: CST & MST (24 Hour Time)
Central USA To:

	10/15 Meters	*20 Meters*	*40 Meters*	*80/160 Meters*
Western & Central Europe & North Africa	08-12 (1)* 06-07 (1) 07-09 (2) 09-11 (3) 11-12 (2) 12-13 (1)	05-06 (1) 06-08 (3) 08-10 (2) 10-12 (3) 12-15 (4) 15-18 (3) 18-20 (2) 20-21 (1)	17-18 (1) 18-21 (2) 21-01 (3) 01-02 (2) 02-03 (1)	19-22 (1) 22-00 (2) 00-01 (1)
Northern Europe & European USSR	06-08 (1) 08-10 (2) 10-11 (1)	06-07 (1) 07-10 (2) 10-12 (3) 12-13 (2) 13-16 (1)	18-01 (1)	20-23 (1)
Eastern Mediterranean	08-11 (1)* 07-08 (1) 08-11 (2) 11-13 (1)	06-07 (1) 07-09 (2) 09-12 (1) 12-18 (2) 18-22 (1)	19-23 (1)	20-22 (1)
West Africa	08-10 (1) 10-12 (2)* 12-14 (1)* 06-09 (1) 09-11 (2) 11-12 (3) 12-14 (4) 14-15 (3) 15-17 (2) 17-18 (1)	03-04 (1) 04-06 (2) 06-12 (1) 12-14 (2) 14-15 (3) 15-17 (4) 17-19 (3) 19-22 (2) 22-01 (1)	19-22 (1) 22-00 (2) 00-02 (1)	21-00 (1)
East & Central Africa	10-16 (1)* 06-11 (1) 11-13 (2) 13-15 (3) 15-16 (2) 16-18 (1)	05-14 (1) 14-16 (2) 16-19 (3) 19-22(2) 22-00 (1)	20-01 (1)	23-00 (1)
South Africa	08-09 (1)* 09-11 (2)* 11-13 (1)* 06-10 (1) 10-12 (2) 12-15 (3) 15-16 (2) 16-17 (1)	06-13 (1) 13-15 (2) 15-17 (3) 17-20 (2) 20-22 (1) 22-00 (2) 00-02 (1)	18-20 (1) 20-21 (2) 21-23 (1)	19-21 (1)
Central Asia	07-10 (1) 17-18 (1) 18-19 (2) 19-20 (1)	06-07 (1) 07-09 (2) 09-11 (1) 17-19 (1) 19-21 (2) 21-22 (1)	06-08 (1) 18-20 (1)	*Nil*
Southeast Asia	16-18 (1)* 08-15 (1) 15-18 (2) 18-20 (1)	06-07 (1) 07-09 (2) 09-14 (1) 18-19 (1) 19-20 (2) 20-22 (1)	04-07 (1) 17-19 (1)	*Nil*
Pacific Islands & New Zealand	12-14 (1)* 14-16 (2)* 16-18 (1)* 10-14 (1) 14-16 (2) 16-17 (4) 17-18 (3) 18-19 (2) 19-21 (1)	06-07 (1) 07-09 (3) 09-11 (2) 11-18 (1) 18-19 (2) 19-21 (3) 21-00 (2) 00-02 (1)	23-01 (1) 01-06 (3) 06-07 (2) 07-09 (1)	00-02 (1) 02-06 (2) 06-07 (1) 03-06 (1)†
Far East	15-19 (1)* 07-09 (1) 13-16 (1) 16-19 (2) 19-20 ([illegible])	06-07 (1) 07-10 (2) 10-12 (1) 16-19 (1) 19-23 (2) 23-02 (1)	03-09 (1)	02-04 (1)
Australasia	14-16 (1)* 16-17 (2)* 17-18 (1)* 10-14 (1) 14-16 (2) 16-19 (3) 19-20 (2) 20-21 (1)	06-07 (1) 07-12 (2) 12-16 (1) 16-18 (2) 18-22 (3) 22-00 (2) 00-03 (1)	02-04 (1) 04-07 (2) 07-09 (1)	02-04 (1) 04-07 (2) 07-08 (1) 05-07 (1)†
Northern & Central South America	07-09 (1)* 09-12 (2)* 12-16 (3)* 16-17 (1)* 06-08 (1) 08-10 (2) 10-14 (3) 14-16 (4) 16-18 (3) 18-19 (2) 19-20 (1)	05-06 (1) 06-07 (2) 07-09 (3) 09-11 (2) 11-12 (1) 12-14 (2) 14-16 (3) 16-19 (4) 19-22 (3) 22-00 (2) 00-02 (1)	18-19 (1) 19-21 (2) 21-02 (3) 02-04 (1) 04-05 (2) 05-06 (1)	19-21 (1) 21-02 (2) 02-05 (1) 00-03 (1)†
Southern Brazil, Argentina, Chile & Uruguay	08-11 (1)* 11-12 (2)* 12-14 (3)* 14-16 (2)* 16-18 (1)* 06-08 (1) 08-10 (2) 10-12 (1) 12-14 (2) 14-15 (3) 15-17 (4) 17-18 (2) 18-19 (1)	00-07 (1) 07-09 (2) 09-14 (1) 14-16 (2) 16-19 (4) 19-20 (3) 20-00 (2)	20-21 (1) 21-02 (2) 02-04 (1) 04-05 (2) 05-06 (1)	21-05 (1) 01-04 (1)†
McMurdo Sound, Antarctica	08-16 (1)* 07-08 (1) 08-10 (2) 10-15 (1) 15-17 (2) 17-19 (1)	15-17 (1) 17-19 (2) 19-22 (3) 22-01 (2) 01-07 (1) 07-09 (2) 09-11 (1)	23-06 (1)	*Nil*

Time Zone: PST (24 Hour Time)
Western USA To:

	10/15 Meters	*20 Meters*	*40 Meters*	*80/160 Meters*
Western & Central Europe & North Africa	08-11 (1)* 07-08 (1) 08-12 (2) 12-13 (1)	05-06 (1) 06-08 (2) 08-10 (1) 10-12 (2) 12-14 (1) 14-16 (2) 16-22 (1)	18-00 (1)	19-23 (1)
Northern Europe & European USSR	03-10 (1)	06-07 (1) 07-09 (2) 09-11 (1) 11-12 (2) 12-16 (1)	21-00 (1)	*Nil*
Eastern Mediterranean	07-10 (1)	06-07 (1) 07-09 (2) 09-11 (1) 11-13 (2) 13-16 (1) 19-20 (1) 20-21 (2) 21-22 (1)	18-22 (1)	*Nil*
West Africa	09-13 (1)* 06-10 (1) 10-12 (2) 12-15 (3) 15-17 (2) 17-18 (1)	06-10 (1) 10-14 (2) 14-16 (3) 16-18 (4) 18-19 (3) 19-20 (2) 20-22 (1)	18-23 (1)	18-22 (1)
East & Central Africa	08-11 (1)* 06-11 (1) 12-14 (2) 14-16 (1)	06-10 (1) 10-13 (2) 13-17 (3) 17-19 (2) 19-22 (1)	18-22 (1)	*Nil*
South Africa	08-12 (1)* 06-10 (1) 10-12 (2) 12-14 (3) 14-15 (2) 15-16 (1)	06-13 (1) 13-15 (2) 15-17 (3) 17-21 (2) 21-00 (1)	18-19 (1) 19-20 (2) 20-21 (1)	18-19 (1)
Central Asia	16-17 (1) 17-19 (2) 19-20 (1)	06-07 (1) 07-09 (2) 09-11 (1) 16-18 (1) 18-20 (2) 20-21 (1)	07-09 (1) 17-19 (1)	*Nil*

[*Continued on page 106*]

Contest Calendar

BY FRANK ANZALONE,* W1WY

Calendar of Events

October 1-2	WADM C.W. Contest
October 1-3	Massachusetts QSO Party
October 1-2	VK/ZL Oceania Phone
October 8-9	VK/ZL Oceania C.W.
October 7-9	SWL Sweepstakes
October 15-16	RSGB 21/28 mc Phone
October 15-16	VU2/4S7 DX C.W.
October 15-16	California QSO Party
October 19-20	YLRL C.W. Party
October 22-23	**CQ WW DX Phone**
October 29-30	RSGB 7 mc Phone
October 29-30	VU2/4S7 DX Phone
October 29-31	Maryland/DC QSO Party
November 2-3	YLRL Phone Party
November 5-7	Delaware QSO Party
November 12-13	OK DX C.W. Contest
November 12-13	RSGB 7 mc C.W.
November 12-14	ARRL SS Phone
November 19-21	ARRL SS C.W.
November 26-27	**CQ WW DX C.W.**

1966 CQ World Wide DX Contest

Phone

Starts: 0000 GMT Saturday, October 22
7:00 P.M. EST Friday, October 21
4:00 P.M. PST Friday, October 21
Ends: 2400 GMT Sunday, October 23
7:00 P.M. EST Sunday, October 23
4:00 P.M. PST Sunday, October 23

C.W.

Starts: 0000 GMT Saturday, November 26
7:00 P.M. EST Friday, November 25
4:00 P.M. EST Friday, November 25
Ends: 2400 GMT Sunday, November 27
7:00 P.M. EST Sunday, November 27
4:00 P.M. PST Sunday, November 27

WADM C.W.

Starts: 2000 GMT Saturday, October 1
Ends: 2000 GMT Sunday, October 2

Its the world working the DMs on c.w. and all band, 3.5 thru 28 mc.

1. There are three divisions, single operator, multi-operator and s.w.l.

2. Conventional number exchange, RST plus a progressive 3 figure QSO number starting with 001.

3. Each contact counts 3 points and the same station may be worked once per band. (s.w.ls get 1 point for each new DM call and serial number listed.)

4. Multiplier is determined by DM districts worked on each band. (Last letter in call identifies the district.)

5. Final score is determined by sum of QSO points multiplied by the sum of districts worked on all bands. Scoring is based on all band operation only.

6. Each contestant will receive a listing showing his standing. Certificates to the top scorers of course.

7. Use a separate log sheet for each band. Also include a summary sheet with the scoring and other pertinent information, and your name and address in BLOCK LETTERS.

8. Mailing deadline is October 30th. Your logs go to: Radioclub of the GDR, DM Contest Bureau, P.O. Box 30, 1055 Berlin, German Democratic Republic.

DM Districts

A—Resteak	F—Cottbus	K—Suhl
B—Schwerdn	G—Magdeb.	L—Dresden
C—Neubr.	H—Haile	M—Leipzig
D—Potsdam	I—Erfurt	N—Marx/Stradt
E—Frankf.	J—Gera	O—Berlin

Massachusetts QSO Party

Starts: 2300 GMT Saturday, October 1
Ends: 0500 GMT Monday, October 3

Complete rules in last month's CALENDAR. Mail your logs before Oct. 24th to: M.I.T. Radio Society, W1MX, Box 558, 3 Ames St., Cambridge, Mass. 02139.

VK/ZL/Oceania DX

Phone—October 1-2 **C.W.**—October 8-9
Starts: 1000 GMT Saturday. Ends: 1000 GMT Sunday in each instance.

Rules same as in the past few years and covered in last month's CALENDAR.

Get your log to: N.Z.A.R.T. Contest Committee, Box 489, Wellington, New Zealand before Jan. 21, 1967.

RSGB 21/28 mc Phone

Starts: 0700 GMT Saturday, October 15
Ends: 1900 GMT Sunday, October 16

Conditions might be favorable for this World to British Isles contest. Check rules in Sept. CALENDAR.

Mailing deadline is October 31st and logs go to: R.S.G.B. 21/28 mc Contest Committee, 28 Little Russell Street, London, WC1, England.

VU2/4S7 DX

C.W.—Oct. 15-16 **Phone**—Oct. 29-30
Starts: 0600 GMT Saturday. Ends: 0600 GMT Sunday in each instance.

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*14 Sherwood Road, Stamford, Conn. 06905.

This should offer a good opportunity to work some Asian DX, conditions and activity permitting. See September CALENDAR for details.

Mail logs before Nov. 15th to: A.R.S.I. Contest Committee: P.O. Box 534, New Delhi 1, India.

SWL Sweepstakes

Starts: 2100 GMT Friday, October 7
Ends: 2400 GMT Sunday, October 9

We don't have a s.w.l. department but will publish this announcement in the interest of possible future Hams.

Log as many different stations, in different states and provinces, on all bands and modes, during the prescribed time. Show calls of both stations in QSO, GMT, band, mode and signal report. Compute your score by multiplying the number of stations heard by the number of states and provinces. Awards will be given to the two top scorers in each state, province and country, as well as other awards.

Logs are due by December 3rd and go to: The Riverdale SWL Association, att: Carl Durnavich, WN9PQY, 6 East 140th Court, Riverdale, Ill. 60627. Include a s.a.s.e. for the results.

California QSO Party

Starts: 2200 GMT Saturday, October 15
Ends: 2200 GMT Sunday, October 16

This is the 1st annual QSO Party organized by the Claremont Ham Club of California.

All bands and modes may be used and the same station may be worked on c.w. and phone.

Exchange: QSO number, RS/RST, and QTH. County for Calif., state, province or country for others.

Scoring: Calif. stations 1 point per contact including in-state QSOs, multiplied by states, provinces and countries worked. All others 1 point per contact multiplied by number of Calif. counties. (max of 58)

Frequencies: 1910, 3550, 3725, 3900, 7075, 7175, 7220, 14075, 14300, 21075, 21125, 21300, 28075, 28700.

Awards: Certificates to the top 3 stations in each state and province, and the top scorer in each country. The top 25 Calif. entries and top 5 Novices are also in line for awards.

Mailing deadline is November 10th and logs go to: Claremont Ham Club, c/o Tom Frenaye, WB6KIL, 617 Purdue Drive, Claremont, Calif. 91711. Include a large s.a.s.e. if you desire the results.

Maryland/DC QSO Party

Starts: 2300 GMT Saturday, October 29
Ends: 0100 GMT Monday, October 31

This is the first MD/DC QSO Party sponsored by the Maydale Amateur Radio Club.

A station may be contacted once on each band and mode. Submit a separate log for each mode.

Exchange: QSO number, RS/RST, city and county for MD/DC stations. (Independent cities, Baltimore and Washington, only send city.) All others send QSO number, RS/RST, city and ARRL section or country.

Scoring: Two points for each completed contact. MD/DC stations multiply by sum of different cities and again by sum of ARRL sections and countries. All others use MD/DC cities as the first multiplier and Maryland counties for the second.

Awards: Certificates to the highest scoring station in each ARRL section and country.

Frequencies: 3573, 3875, 7075, 7275, 14075, 14275, 21075, 21352 and 50.1 and 145.1 as well as 3735, 7175 and 21110 for Novices.

A signed declaration is requested along with a summary sheets. Include a s.a.s.e. if you desire the contest results.

Mailing deadline is November 21st and logs go to: Carl E. Andersen, K3JYZ, 14601 Claude Lane, Silver Spring, Maryland 20904.

YLRL Anniversary Party

C.W.—Oct. 19-20 **Phone**—Nov. 2-3
Starts: 1700 GMT Wednesday. Ends: 2300 GMT
Thursday in each instance.

The rules for this contest appeared in the September issue on page 32.

Delaware QSO Party

Starts: 2300 GMT Saturday, November 5
Ends: 0500 GMT Monday, November 7

This is the 11th annual QSO party given by the Delaware Amateur Radio Club of Wilmington. All bands and modes may be used and credit will be given for working the same station on different bands.

Exchange: QSO number, RS/RST, and QTH. County for Delaware, state, province or county for others.

Scoring: Delaware stations 1 point per contact multiplied by number of states, provinces and countries. All others 5 points per contact multiplied by the number of Delaware counties worked.

Frequencies: 3525, 3825, 3975, 7025, 7225, 7275, 14025, 14225, 14325, 21025, 21325, 21425, 28025, 28650, 29000, 50, 50.4, 144.

Awards: A certificate wlil be awarded to the highest scoring station in each state, province, and foreign country. In addition a W-DEL certificate will be sent to any station working all three Delaware counties.

Mailing deadline is Dec. 5 and logs go to: Delaware Amateur Radio Club, c/o J. E. McCarley, K3NMY, P.O. Box 201, Newark, Delaware.

RSGB 7 mc DX

Phone—Oct. 29-30 **C.W.**—Nov. 12-13
Starts: 1800 GMT Saturday, Ends: 1800 GMT
Sunday in each instance.

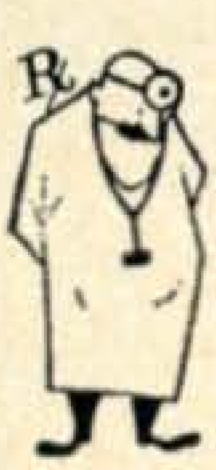
Its the world working the British Isles in this one. Contacts must be made in that portion of the 7 mc band for which the entrant is licensed. And this year multi-operator entries are permitted.

Exchange: The usual 5 and 6 figures, RS/RST plus a progressive 3 digit contact number starting with 001.

[*Continued on page 102*]

HAM CLINIC

CHARLES J. SCHAUERS,* W6QLV



I WOULD like to start this month's column off by thanking those HAM CLINIC readers who have written to me and told me how much they enjoy the column. A few excerpts read like these: "I always turn to HAM CLINIC when I receive *CQ*—keep up the good work." "I subscribe to *CQ* only for your column, thanks for all the good usable information every month." "How you do it I don't know, but if your mail volume is indicative of the type of stuff one reads in your column you must have a task on your hands!" (yep) "This is my third letter to you and you have always helped me—keep HAM CLINIC humming." "Your writing is straight and to the point, one of your tips saved me time and money so I am subscribing for another year." "Just a word to let you know I appreciate your effort every month. Your contribution to ham radio over the years is commendable."

Again dear readers, thanks a mega-times.

Modifications of Commercial Gear

A large number of articles have been written on the modification of commercially made ham equipment and no doubt there will be many more. When readers ask us to supply them with article references for modification instructions on their sets we do our level best to comply, but we cannot undertake to supply step-by-step modifications on a personal basis—we simply do not have that much time in a day. You may however, ask us if a contemplated modification you desire is feasible and we will give you our unbiased opinion (along with references if any). See the first question this month.

Incidentally, our answers are as brief as we can make them, because when a stack of 200 letters faces us we must move fast. The largest number of letters received during any month since starting the column was 564—now that is a lot of correspondence!

NCX-3 to 6 Meters—"I have an NCX-3 transceiver and would like to convert it for operation on 6 meters. Is this possible? How big a job is it? How expert must one be to do it and what your ideas?"

This is a question we receive all the time. If I had an NCX-3 I would be tempted to try a modification for 6 meters.

Any current h.f. transceiver can be made to operate on 6 meters providing enough time and effort are expended on the project. The outcome however will depend on one's level of technical skill and how much one is willing to "butcher up" the set.

To modify the NCX-3 for 6 meter operation using the original chassis would be quite a job! Of course, outboard equipment could be designed for use with the NCX-3 such as a receiver section converter and a transmitter section exciter feeding the modified final r.f. amplifier.

Another approach would be to feed the NCX-3 output into a mixing unit to obtain 50 mc s.s.b. to drive a separate 6 meter final and use either a separate receiver or converter. The r.f. output for this purpose could come from the driver or final r.f. stages of the NCX-3.

It is a difficult task to modify any of today's transceivers (that cover 10 to 80 meters) for 6 meter operation and still retain the transceive feature—but believe me it is not impossible.

You can well imagine the amount of work involved modifying a set even if the 10 meter section of the transceiver is converted for 6 meter operation. New coils must be installed, one or two new mixing stages, a few tuned circuits added, calibration made etc. and this is no task for a beginner.

CB Set for Ham Operation—"Thanks to your encouragement and assistance I passed my General Class ham exam and now am the proud owner of a license. Using my CB rig I thought talking to roving mobiles and 'phantom stations' was a lot of fun but not anymore. Sure the ham bands are pretty full but not as crowded as the CB. I still want to use my CB sets for the purpose intended but would like to be able to use my mobile unit on 10 meters. Is there any law against this and what do you suggest?'

Bravo I agree with our Editor Dick Ross on the conversion of CB "hobbyists" to amateurs and the best way to do this is to demonstrate to the CB'er that ham radio is more fun. You hams: invite CB'ers to your hamshack, let them listen to the bands and hear you work the world! Yes, you can use your mobile unit for 10 meter operation as well as CB functions. Most CB sets can be modified for ham operation in the 28.5 to 29 mcs portion of 10 meters *without* too much work. *But* the work *must* be done by one who has a commercial 2nd Class Radiotelephone ticket or higher. Using the *highest* CB channel position plug in the proper 28-29 mc crystal and determine whether or not the tuned circuits will cover

HAM CLINIC is a free technical question and answer service provided exclusively by *CQ*. Every attempt is made to answer each reader's question as promptly and accurately as possible. Occasionally, even HAM CLINIC is stumped, but it rarely happens. Readers are requested to enclose a stamped, self addressed envelope with their questions, to facilitate fast replies. For *extra* fast service, write directly to: Ham Clinic, c/o Chuck Schauers, W6QLV, 4 Lutzelmatte Str., Luzern, Switzerland. Enclose two IRC's. Normal inquiries: Ham Clinic, c/o *CQ*, 14 Vanderventer Ave., Port Washington, L.I., N.Y. 11050.

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*c/o *CQ*, 14 Vanderventer Ave., Port Washington, L.I., N.Y.

a portion of the lower end of the 10 meter phone band. If so, you are in business without modification. If not, some work may have to be done on the oscillator, driver and final tank circuits. Any modifications must *not* influence or change the operational characteristics of the set for CB operation.

Usually, if you are going to use a current CB set for hamband operation only, a few turns (from 1½ to 3) from most coils in the set will put you in the 28-29 mc hamband. When you do this however, your CB set *cannot legally* be used again on CB, unless restored to its former condition by a licensed commercial operator—remember this.

I cannot leave this question without saying one more thing: I sincerely believe that the FCC should create a new class of CB'er—let's call it the *Radio Amateur CB Class*. Current "hobbyist" CB'ers would be eligible for this class by taking a simple examination on rules and regulations and operations procedures. They would be assigned 4 of the present 11 meter CB channels for radio amateur type operations using their present 5 watt sets (mobile) and 25 watts fixed. Their call letters would be suffixed with an "A." They could work *any other* radio amateur CB class station in the *U.S. only*. I think this is the answer to the CB hobby problem—outside of converting CB'ers to the wonderful world of full radio amateur operation.

What are your thoughts on the subject?

Improving Inexpensive Receivers—"The other day while shopping for a receiver at Henry Radio in Los Angeles I tried out a few sets from the inexpensive to the very expensive. I noted that I could pick up the same stations on most sets—cheap ones or highly priced. I ended up by buying a used receiver in the $200 range. Now what I want to know is this: what can be done to make the less expensive receiver as good as or better than a high cost set?"

You get what you pay for—make no mistake about this. I know one manufacturer who makes a receiver and sells it for $21,500.00 and it *is* worth every penny. (Name on request.) To nearly anyone excluding commercial and military users this set is really a high priced job. But when the research, engineering, part quality, manufacture and operations are considered this is not the most expensive set.

A multi-band receiver with high stability (1 part in 10^8 per day), digital readout, superior fixed and variable selectivity, low image ratio, low noise, low cross-modulation, excellent a.g.c., all mode (s.s.b., a.m., i.s.b., c.w., f.s.k., fax etc.) operation, effective noise silencing circuitry, superior mechanical construction and built for continuous operation (to name a few features), costs money.

Converting the inexpensive receiver (by ham standards)—a set that costs $100 or less so that it will operate like its $500 "counterpart" is like trying to make a Volkswagon operate like a Cadillac!

Sure, one can add little refinements such as a Q multiplier to the inexpensive receiver. A crystal calibrator may be added, a product detector installed, a variable selectivity circuit incorporated (without Q multiplier), more r.f. gain, a noise silencer and a few other "luxury" controls, but you still wind up with the same bandspread-less dial and its inherent backlash and poor calibration.

However, some hams are happy with the slightest improvement and a number of these have appeared in *CQ* from time to time.

Many hams are using old receivers that have been modified and modified well. I have a friend who has a receiver he bought in 1936 and the only thing that seems to be old on it are the chassis and dial and he is mighty happy.

When specific information for improving receivers is available HAM CLINIC will carry it.

Wideband Filter for 75A-4—"As you no doubt know there are a large number of 75A receivers now available on the used market—I bought a 75A-4. Tell me, is there anyway to add more bandwidth for improved a.m. operation etc.?"

Yes. We have had about 20 requests for this information from 75A owners. On page 50 of *CQ* for January 1964 an article captioned as above can be found that covers the subject.

NC-300 Intermittent—"I have an NC-300 receiver that has given me top notch service, but suddenly it has developed an intermittent. The set will work about 15 minutes, sometimes 20, then suddenly cut out. Turning the on-off or band switches a couple of times made it run again. All voltages check okeh (hot and cold), tubes are okeh and I am stumped. Can you help me please?"

Sure. Intermittents in receivers can usually be traced to bad interstage coupling capacitors. The ones to suspect on the NC-303 are: C_{56}, C_{13}, C_{33} and C_{24}. There are others but these are the most likely to cause the trouble. You might also

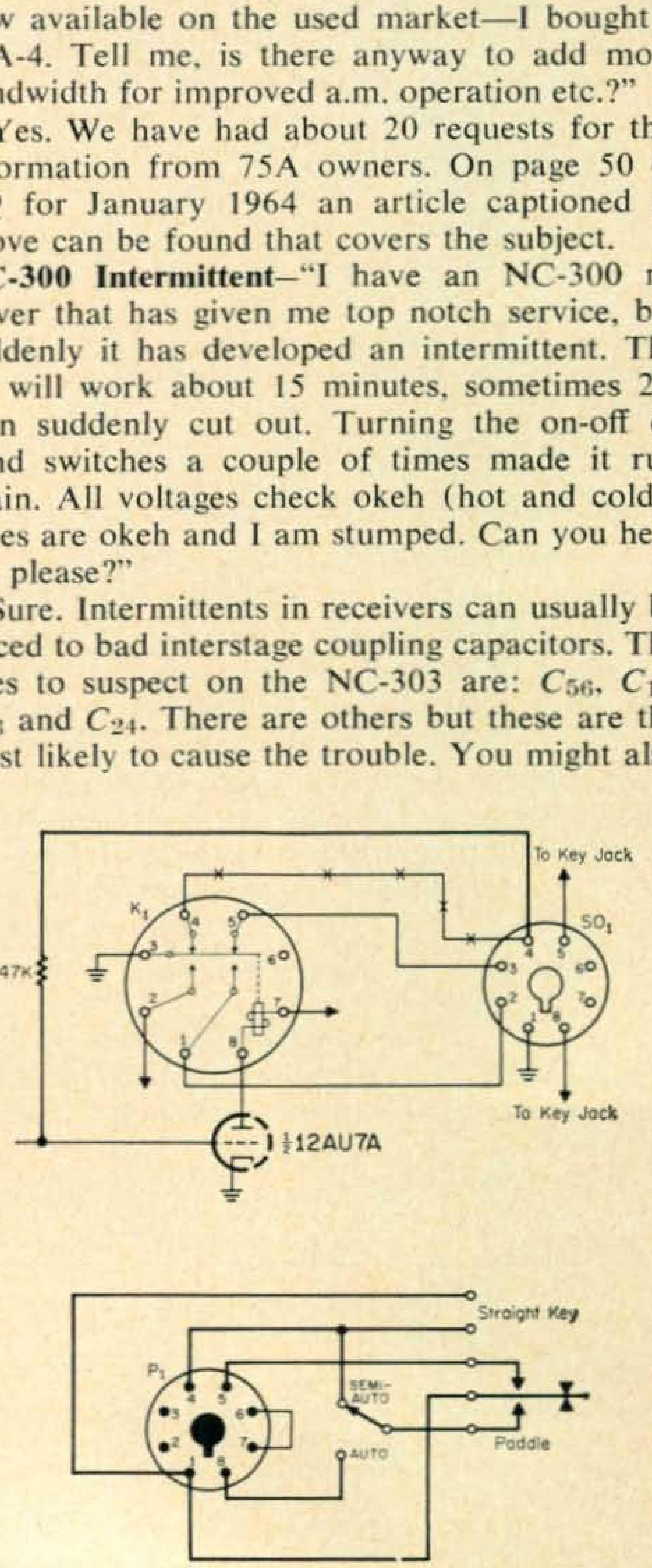

Fig. 1—A method of using a straight key to key the HA-1 T.O. keyer. Heavy lines indicate connections.

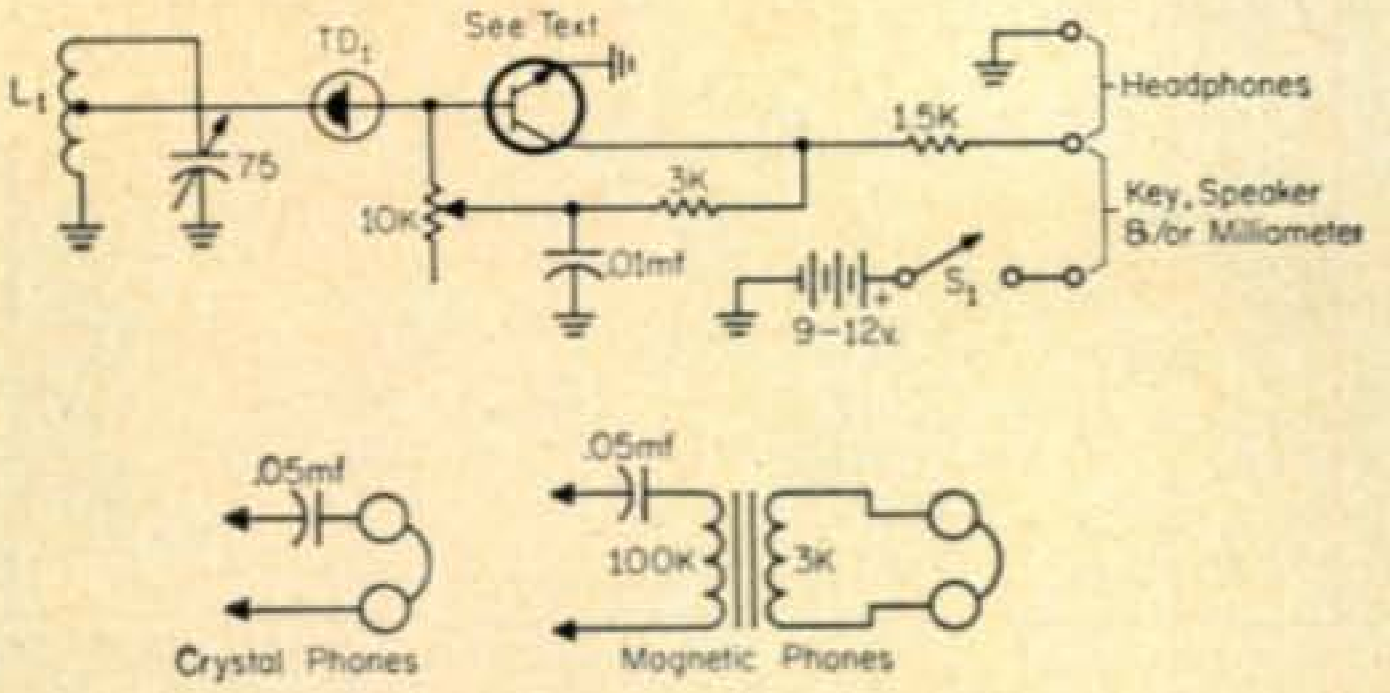

Fig. 2—A combination code practice oscillator, c.w. monitor, wavemeter or transmitter tune-up device. L_1 is cut for 20 meters and consists of 15 turns of No. 20 wire, wound at 16 turns per inch with a ⅝" diameter (B&W Coil No. 3007), tapped 2½ turns from the bottom.

suspect screen and plate supply resistors. Sometimes these will open up when hot and cutting off and resupplying power will "weld" them together for a short time. With the set out of the cabinet bridge suspected parts (when the set stops operating) with the same value part. You'll find your trouble.

Straight Key with HA-1 T.O. Keyer—"Can you tell me how to connect a straight key to the Hallicrafters HA-1 T.O. keyer?"

To key the HA-1 T.O. keyer with a straight key, connect the key so that it grounds the grid of V_{4A} through a 47K ohm resistor. A simple way of making this connection, if you are not using the auxiliary contact connections on the control outlet, would be to remove the present connections to Pin 4 of SO_1 and in its place substitute a 47K ohm resistor from Pin 4 of SO_1 to Pin 2 of V_{4A}. A regular key is then connected between Pin 4 and Pin 1 on the control plug, P_1. See fig. 1. A method of obtaining semi-automatic keying is also shown in the same circuit.

Switching 3 Antennas—"Currently I have 3 coax cables coming into the shack from 3 different antennas. Any suggestion for using only one feeder coax cable?"

Yes. Why not use the Dow Key DK72 s.p.t.t. coax switch? This has been made specifically for the job.

HA-105TR Modification—"I bought a second hand HQ-105TR. As you know this is a receiver (HQ-100A) with an added 5 watt input transmitter for CB. I would like the input power increased for the transmitter and use the set for 10 meter operation. What say?"

It could be done but really is not worth the effort. Even if you doubled power you would only gain 3 db. For local rag chews 5 watts input will work fine, and when the band is open you'll be surprised how far you can reach out with so little power. For increased power you would also have to increase the size of the modulator, boost up the power supply etc.

Keying Monitor-Wavemeter Etc.—"Would you please publish a good c.w. keying monitor that I can use with my transceiver? I am sure many other hams owning transceivers that do not provide a sidetone keying circuit would also like to have one. It should be simple, small and transistorized. Can do?"

Can do. See fig. 2. This gadget can be used not only for c.w. keying monitoring but also as a code practice oscillator, aural and visual wavemeter and transmitter tune-up device. When used as a code practice oscillator or for c.w. monitoring, a loudspeaker or phones are used. As a transmitter tune-up device or wavemeter, a meter is used for r.f. indication and resonance respectively. The coil shown is for the 20 meter c.w. band. If the set is to be used only as a keying monitor or code practice set then a coil (without tuning capacitor) consisting of 2¾ turns of No. 18 about 2¼" diameter should be connected in place of the 20 meter tuned circuit. The tunnel diode can be any good inexpensive TD, in this one a TD-1 from General Electric is used. The transistor can be any of the following: GE-5, 2N635A, 2N1304 or 2N1302. If the coil used does not seem to have enough pickup, merely attach a No. 18 covered wire to the coil (any point) and place it near the r.f. source. The unit can be built in the smallest minibox and binding posts used for the coils, etc.

Increased Sensitivity on NC-66—"I have an old NC-66 receiver. Any way to increase the sensitivity on Band 3?"

Yes. Change C_1 from 15 mmf to 270 mmf. Change R_6 from 47K to 100K and change C_{21} from 270 mmf to 47 mmf. Then realign the set. This will greatly improve the sensitivity on band 3.

Eliminating 2200 kc Signal—"My receiver picks up a signal that I have determined is coming from a station on 2200 kc. Any method for eliminating this bothersome signal?"

Yes. Obtain an iron slug tuned coil form that has a diameter of a quarter inch. Space wind 17 turns of No. 24 cotton coated wire on the form. Now parallel the coil with a capacitor of about .0025 mf. Place the coil in series with the antenna and receiver. Tune the slug to eliminate the interference.

Fan Recommendation for 230 V 50 c.p.s.—"I need a small fan for cooling one of the tubes in a transmitter I have just finished. I only have about 3" of space and I am wondering if you could recommend a fan for the purpose. I want a quiet running fan that I can depend on—no $1.98 units. As you can see by my address I am stationed in Germany with the U.S. forces and the fan must handle 230 volts 50 c.p.s. Can you help me?"

Yes. Try the model SP2A7, the Sprite (Tm) made by the Rotron Manufacturing Co., Woodstock, N. Y. This little fan (3" square and about 1½" deep) operates on 230 volts 50 c.p.s. and is available in other voltages and frequencies. It is a professional unit and just about the best one can buy.

Thirty

I would like to remind readers writing to HAM CLINIC to please include return postage (2 IRC's or 25¢ in coin). Again thank you for writing—but also let the editor know directly what you think of HAM CLINIC—he's the boss.

73, Chuck, W6QLV

the USA-CA PROGRAM

BY ED HOPPER,* W2GT

THE "Story of The Month" about Charley, W0JWD, after this data on awards issued. Two new USA-CA-3000 award winners, #6 Charley, W0JWD (who also received All 7 mc 2 × s.s.b. endorsement for his USA-CA-2500 award) and #7 "Pappy", WA9AJF. I hope to have a story on Pappy for next month. USA-CA awards for 1500, 1000, and 500 went to "Rock", WA8CLZ. John, W4WSF received a USA-CA 1500 mixed award and All 7 mc endorsement for his USA-CA-500 award. Ray, W1UOT received a Mixed USA-CA-1000 award. USA-CA 500 awards for mixed operations went to Roger, K1FHL; Carrie (XYL), WA4BVD; Edward, WB6HQQ/K9BHE and Michael, WA0KGD. Charles, W9FJX received a USA-CA 500 award endorsed All A-1 as did Paul, OZ4H and Paul's was the first USA-CA award to an OZ station. Richard, WA0EDN received a USA-CA 500 award endorsed All s.s.b.

Charles O. Rick, W0JWD
USA-CA-3000 Award Winner #6

Charley was born in 1924 and he and XYL have 3 boys aged 15, 17 and 19. Mike and Steve are in high school and Randy is a 3rd year college student at the University of Missouri majoring in geophysics.

Charley is a broadcast engineer, presently chief engineer for KWK a 5 kw, 24 hour good music station.

His Dad was a Doctor of Optometry, so Charley's first job was in the optical business but he moved into radio in 1939 and worked for Walter Ashe Radio until 1948. His amateur license had been obtained early in 1940.

USA-CA HONOR ROLL

3000		**1000**		WA0KGD	580
W0JWD	 6	W1UOT	103	W9FJX	581
WA9AJF	 7	WA8CLZ	..104	K1FHL	582
1500		**500**		WA4BVD	583
WA8CLZ	 52	OZ4H	578	WA0EDN	584
W4WSF	53	WA8CLZ	579	WB6HQQ/ K9BHE	585

In 1948, Charley moved into broadcast work and has built about 8 stations including 50 kw, 6 tower, a.m., f.m. and TV stations and he dearly loves the construction aspect of broadcast work. He is a licensed pilot, a member of the Coast Guard Auxiliary, local radio clubs and a boater.

As for county hunting—who else but his long time friend—Art, W0MCX introduced Charley to the most fascinating phase of amateur radio and Charley feels that the gang of county hunters are tops. He has met many in person and plans to meet more and feels that the whole world could use more of the congenial attitude that prevails amongst this bunch of hams who many times miss a new county themselves in order to help another hunter get a needed one.

His awards number about 50, the oldest R.C.C. and his proudest is USA-CA. Others include DXCC, A-1 Op., OTC and amateur "Extra Class".

Equipment includes 75S3-B, 32S-3 and home brew final with a pair of 4-400A tubes in grounded grid. Antennas include a TA-36 at 75 feet and a 2 meter ground plane at 83 feet and a 40/75 meter Mor-Gain. His QTH is unique in that the home was built in the late 1890s and he has no problem over antennas—he married his landlady, Hi.

For his *many* mobile trips Charley has been using an SB-34 but recently got a Swan 350 to increase power and signal strength to help YOU get needed counties.

His USA-CA award record is: 500 #376 received May 1964; 1000 #69, 1500 #29, 2000 #15 and 2500 #7 received in February 1965 and these are all endorsed Mixed and All 7 mc

W0JWD's home and antennas.

W0JWD's shack.

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*103 Whitman St., Rochelle Park, N.J. 07662.

N.W. St. Louis ARC Award

Greater Pittsburgh VHF Award

KLONDIKE AWARD

Klondike Award

KIMCHI AWARD

Kimchi Award

2 × s.s.b. Now he received USA-CA-3000 in July 1966. A photo of Charles was on page 83 of *CQ* of May 1966.

POD Publication 26

"Hank," WB2RMM, writes, "Having recently been bitten by the county hunter's bug, I wrote to the Superintendent of Documents for the recommended Postal Directory to check my counties. After a delay of nearly two months, I was advised that this directory is no longer published.

You and your readers may know, but I did not and it came as an agreeable surprise that Rand and McNally publishes a *Geographic Handbook* which lists all the towns, villages and cities in the U.S. with a population of 100 or more and gives the population *and county*.

The price of this book is $4.00, which is infinitely more attractive than $14.95, the price of Rand, McNally's *Cosmopolitan World Atlas* which also gives this information. If this information saves someone a couple of months time, I will be quite happy."

(Editor's note—Upon telephoning the Superintendant of Documents bookstore it was learned that the 1965 edition of POD 26 was out of print and that the 1966 revised edition would be available after October. The book will sell for $2.75)

Awards

N. W. ST. Louis A.R.C. Award: A new award issued by The Northwest Saint Louis Amateur Radio Club for working five members. Send a GCR list or five QSLs along with $1.00 or 7 I.R.C. to Doug Hughes, K0LGZ, 10433 Arthur Place, Frontenac, Missouri 63131. Funds in excess of handling costs will be used by the club to help finance the annual club sponsored Missouri QSO Party. Members include: K0AXU, ECK, EOD, GSV, IFL, JPG, JPL, LEE, LGZ (or W0JBK), TLO, UPJ, VSH, YIP. W0CED, DQA, TDT, WEQ. WA0FMD and WA0HXP.

Greater Pittsburgh VHF Award: The new v.h.f. award certificate of the Greater Pittsburgh VHF Society of Pittsburgh Penn. is issued to promote the v.h.f. bands. Requirements: For operators in Western Pennsylvania—ten QSOs with ten full members of the society on any v.h.f. amateur band or combination of v.h.f. bands. Other USA operators—ten QSOs, minimum of 6 society members and 4 other Allegheny county operators. All others—minimum 6 QSOs, 4 full members of the society and others in Allegheny county. Send evidence of compliance to Ray (Barney) Barnies, K3TRN, 12 Clovelly Road, Ben Avon Heights, Pittsburgh 2, Pennsylvania. This new certificate will be retroactive to January 1, 1966, and the old one, which it replaces, will cease to be issued July 1, 1966.

Tarheel Certificate

Klondike Award: The Edmonton (Canada) DX Club is pleased to offer this Klondike Award. Requirements: W, K, VE and VO stations need 10 contacts plus $1.00 or 10 I.R.C. All others need 5 confirmed contacts only. General Certificate Rules apply. Apply to: VE6AAV, Sub P. O. 55, North Edmonton, Alberta, Canada. Members include: VE6AAV, ABP, AET, AJJ, AJY, AKP, AKR, ALI, ALX, AQL, BY, CJ, GX, HM, NX, PP, RJ, TP, UR, UV, VV, MC, WR, and WU. Look for club members around 14340 s.s.b. on week-ends between 1800 and 2000 GMT.

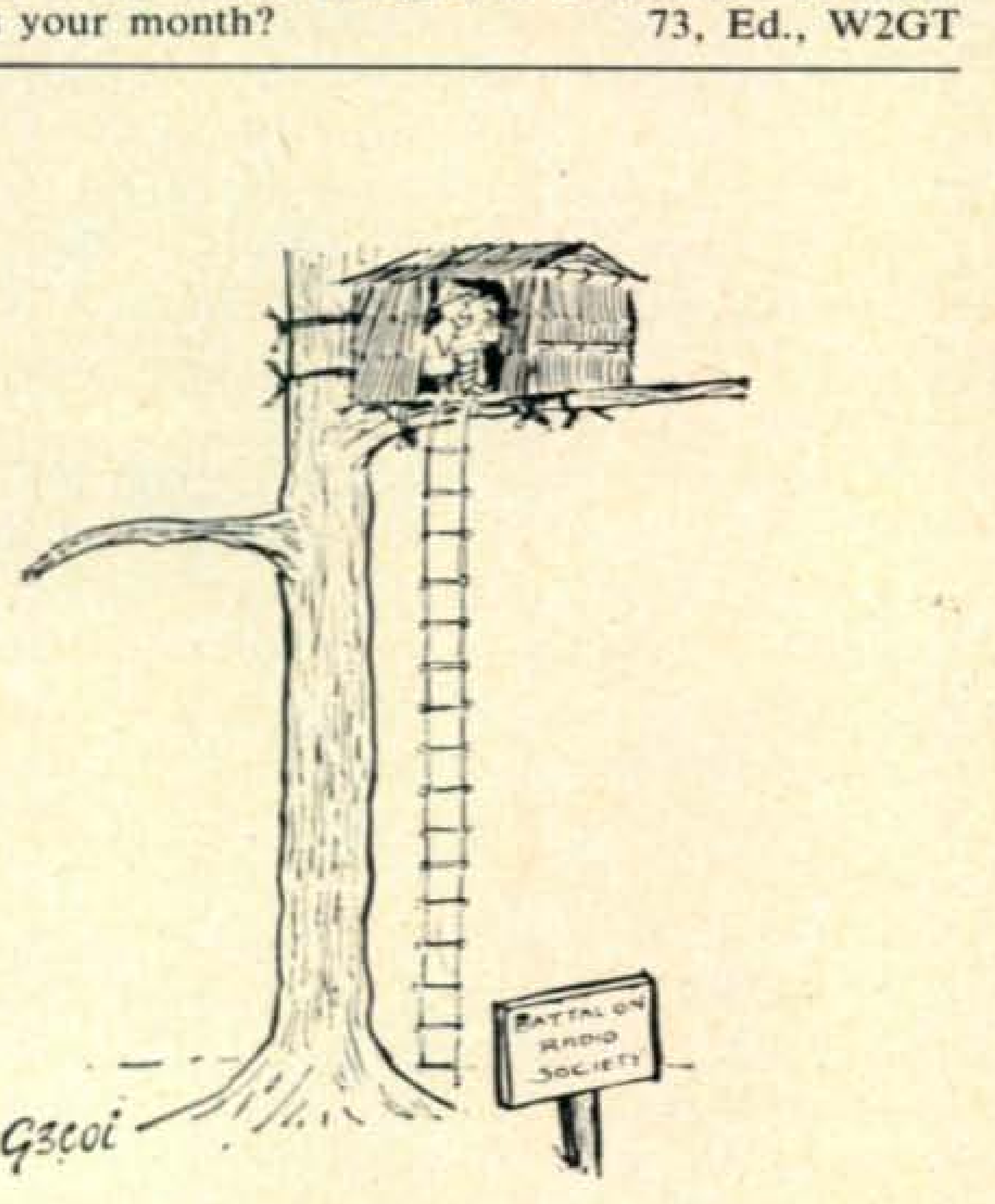
KIMCHI Award: The Eighth United States Army Amateur Radio Club wishes to announce that the requirements for the KIMCHI award were changed effective March 5, 1966 and that they reverted to the rules of 5 months previously: Five (5) two-way HL9 contacts will be required, HL9 QSL cards or complete log data must accompany the application and return postage for the cards, plus 2 IRCs for mailing the award. Send to: Awards Manager, Eighth United States Army Amateur Radio Club, APO San Francisco, California 96301.

Tarheel Certificate: The Morganton Amateur Radio Club is pleased to issue these certificates for confirmed contacts with North Carolina counties. The fee for the basic "D" award is $1.00, higher classes then merely require s.a.s.e. General certificate Rules apply. DX is any location outside the 48 continental states. Canada, Alaska, Hawaii and Mexico are considered DX. All that is required of a DX station is (GCR) certified list and his name and address clearly printed.

Tarheel 30	Class D required	30 counties (25 for DX)
Tarheel 50	Class C required	50 counties (40 for DX)
Tarheel 75	Class B required	75 counties (60 for DX)
Tarheel 100	Class A required	100 counties (90 for DX)

Apply: Awards Manager, Morganton Amateur Radio Club, 118 Falls Street, Morganton, North Carolina 28655.

Just got back from vacation in time to get this under the wire, hope you all had wonderful vacations (holidays), now get busy and send in your applications, Hi. The Top Twenty-five Honor Roll was again omitted due to the lack of significant changes, or notification of them. How was your month? 73, Ed., W2GT



"... So best 73 OM and I'll see you further down the log ..."

SURPLUS sidelights

BY GORDON ELIOT WHITE*

This fall, in the Halloween season, I think it might be appropriate to deal with what I call the "monster" series of Navy receivers. These, the RBA, RBB, RBC, RCK, RDO, RDZ, are World War II vintage sets, built quite obviously to be used on battleships, not aircraft. They all operate from 117 volt, 60 cycle a.c. power, and have a number of similarities from one to the other. They are solid old sets, some of them very good in their way, capable of a lot of rugged service and of serving very well for an amateur shack. They do not measure up to the latest 1966 commercial gear, chiefly in size, styling, and i.f. bandwidth which is obtained today with mechanical filters. But for the Novice, the s.w.l., or as a second receiver in the best of shacks, they can do a very fine job.

Briefly, the RBA is a v.l.f. receiver, using a tuned-radio-frequency circuit. The RBB is a superhet covering 500 kc through 4 mc, with a 400 kc i.f. The RBC is identical to the RBB except for frequency coverage which goes from 4 mc to 27 mc. All three use a separate power supply, usually model CRV 46148 or 20130. (The power supply plugs are practically non-existent, so you may have to replace the Navy style plugs with octal fittings.)

The v.h.f. RCK, which I will cover in more detail below, is part of the slightly later "monster" series. It has its own power supply built on the same chassis as the r.f.-i.f.-a.f. units, a fact that is immediately apparent when you pick up this little creampuff, all 117 pounds of it. The RDO uses a very similar power supply and i.f. section, the chief difference being the 12 mc i.f. for the RCK and 30 mc for the RDO. The RDO is a search receiver, used to look at other people's radar and radio emissions. It is very much like the Air Force AN/APR-1 and APR-4 except that the APR sets are somewhat smaller. Both the RDO and APR units use similar plug-in r.f. heads which tune from 40 mc up into the 4000 mc region. The main receiver section is adapted to feed i.f. signal to an associated panoramic adapter for visual watchkeeping on the bands. Some of the later r.f. heads had 24 volt d.c. motors to drive scanning systems at a predetermined speed.

The RCK, and its re-issued version, the R-432/URR-21, is a four-channel, crystal-controlled v.h.f. receiver covering a possible band from 110 mc to 160 mc. That of course takes in the civil aircraft frequencies, the 2 meter amateur band, and some high-band police and fire frequencies. If you have the proper "rocks" you can plug them in and turn it on. The crystal frequencies can be found by the formula

$$\frac{F_c = F_s + 12 \text{ mc}}{9}$$

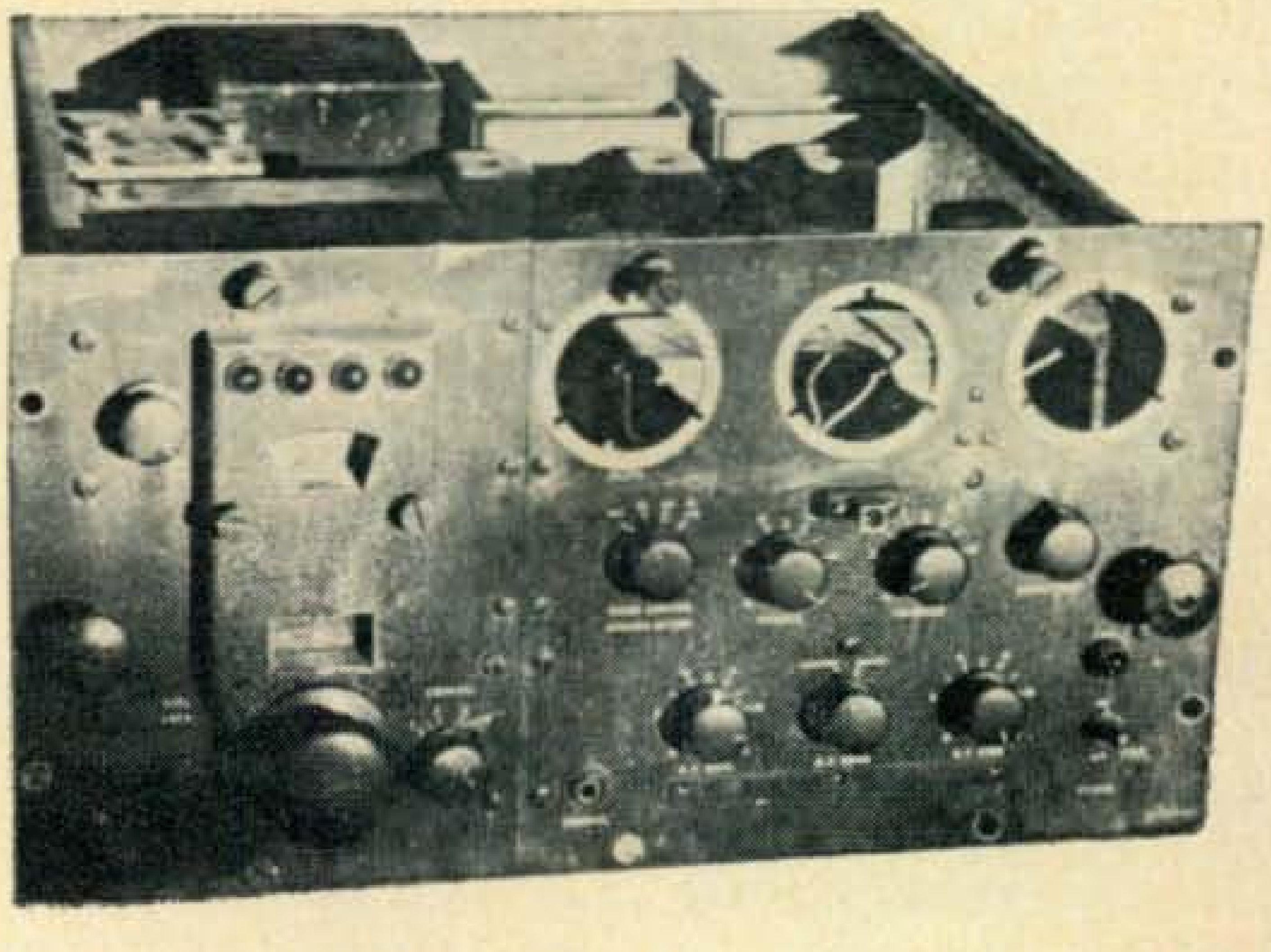
that is, the incoming r.f. signal *plus* the 12 mc i.f. frequency, divided by nine, the crystal multiplier factor.

This is simple enough, if you have the right crystal or like to grind your own. The real sleeper in the RCK is its appearance: It has a tuneable dial, calibrated directly in megacycles, and *looks* as though it was one of those nice *tuneable* receivers. I would wager that a few thousand RCK sets are sitting in amateur attics where they ended up when the proud owner discovered they were *not* tuneable. Especially since some of the Navy crystal controlled equipment can be either crystal or tuneable. There is even a switch inside the r.f. section marked "tune" which ought to be a changeover from crystal to v.f.o. mode. But it isn't.

There seems to be no easy way to make this set tune except by crystal operation, but there is a conversion which I have worked out for *CQ* readers to accomplish the tuneable trick.

The technique is simple, and can be applied to any receiver which employs a series of tuned crystal-multiplier stages which are ganged on a common control shaft. This criteria applies to the RCK, the FRR-21, the R-28/ARC-5, the BC-942, the RDZ, and several other surplus items. To accomplish the switch you must adjust the oscillator so that it is self-exciting without the crystal. Hopefully it will oscillate at the same frequency (although not with crystal-like stability of course) and the v.f.o. signal will feed through the intervening multipliers to the mixer just as it did from the original crystal mode.

On some receivers it is easy to add a little feedback between the plate and grid of the oscil-



This old model RCK vhf receiver was a bargain at $10 after someone had stripped out the meters. It had been abandoned because the dealer thought it could not be made tuneable. Despite its battered condition it was converted into a fair 2-meter receiver with only oscillator—circuit changes. The leads to the missing meters were taped up, and a neon bulb substituted for the B+ meter. Another neon could be used in place of the output meter to give a rough indication of the relative audio power from the set.

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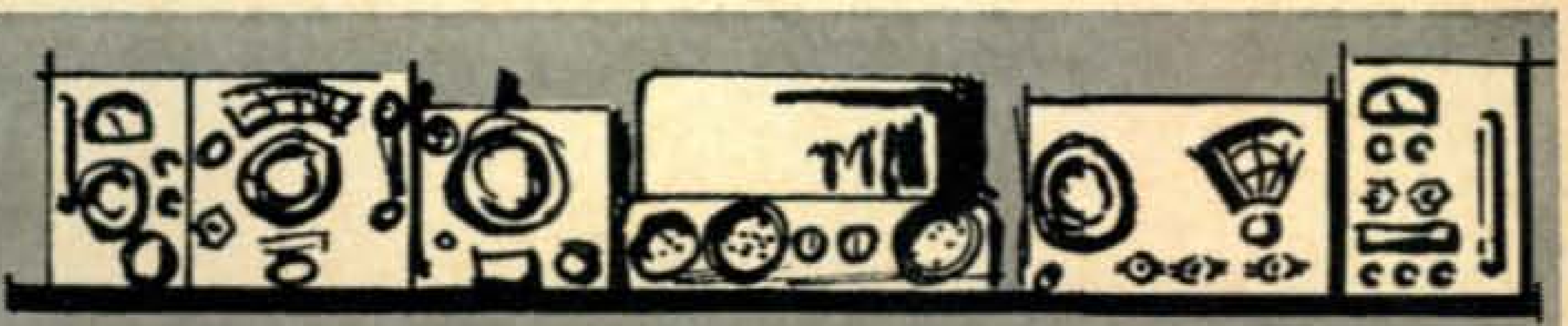
*5716 N. King's Highway, Alexandria, Virginia 22303.

SURPLUS CORNER



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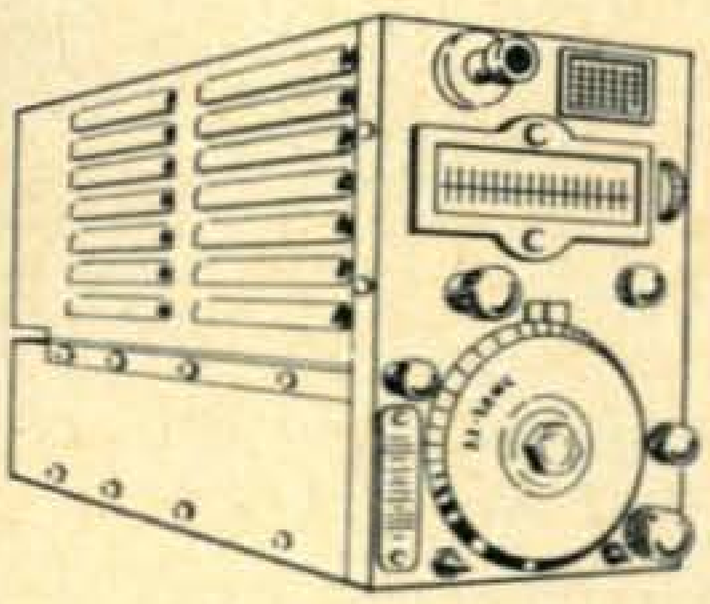

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AN/GRC-3, 4, 5, 6, 7, 8, 10, 19, 26, 27, 46, VRC-12
AN/PRC-8, 9, 10, 25
Test equipment with ARM, SG, URM, UPM, USM, and TS prefixes
Communications: AN/TRC-1, 24, 35, 36
Receivers: AN/APR-9, 13, 14, R-388A, R-274, R-390A, R-391, R-392, etc.
Indicators: ID-250, 251, 387, 257A, etc.
Aircraft: AN/ARC-27, 34, 38, 44, 52, 55, 57, 73, 84
AN/ARN-14, 59, 67, 70
AN/APS-42, 81
AN/APN-3, AN/CPN-2A, AN/APN-84
Also: Tektronix, Hewlett Packard, Boonton, and General Radio equipment, etc.

Liberty Electronics, Inc.

548 Broadway, New York, New York 10012, Phone 212 - 925 - 6000

For further information, check number 24, on page 112

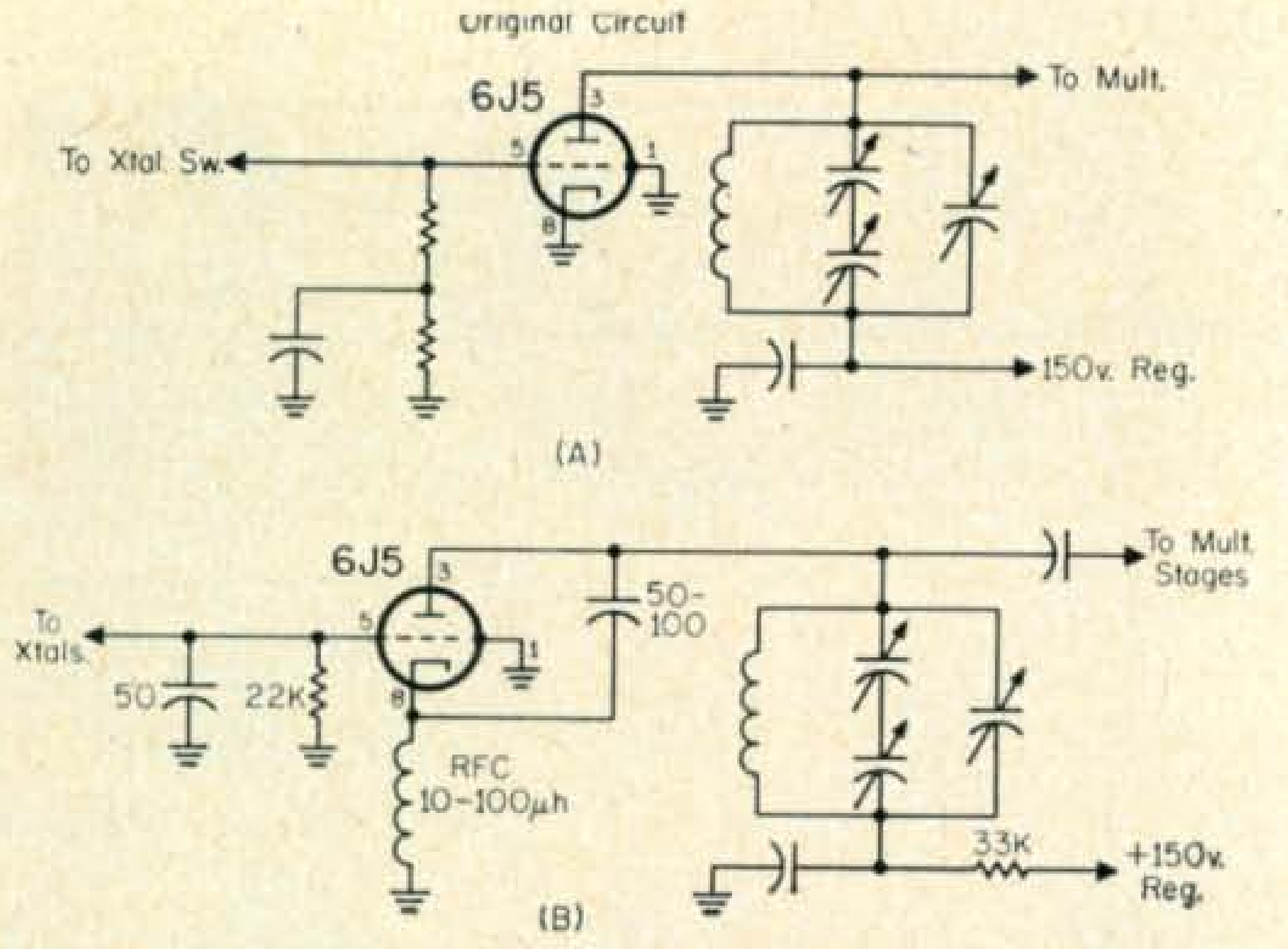


Fig. 1—(A) Original circuit of the RCK oscillator. (B) Simple modification to make the unit tunable over a 10 mc range.

lator tube to make the oscillator take off on its own. This is not the case with the RCK, apparently because the 6J5 triode, with a pretty soggy tranconductance curve, provides too little gain. You have to go further than adding a 100 mmf ceramic disc.

The quick-and-dirty way is to boost the crystal circuit so that it will oscillate a great deal above and below the crystal frequency. On the RCK you can cut loose the cathode from its ground connection, put an r.f. choke of between say 10 to 100 μh, in between cathode (pin 8) and ground, and add a feedback capacitor of 50 to 100 mmf from the cathode to the plate (pin 3). You will still need the crystal, and you won't be able to tune more than a 10 mc area, but it will work. See fig. 1.

The best way I have found, is to go a little deeper. Remove the crystal selector shaft by loosening the shaft coupling in the oscillator compartment underneath the receiver. Following fig. 2, remove the wire leading from pin 5 of the 6J5 oscillator tube to two resistors and a capacitor on the adjacent terminal board. There is also a lead in the pin 5 (grid) circuit leading to a test jack which can be omitted as well. Replace the grid circuit components with 22,000 ohm, 1 watt resistor and a 50 mmf capacitor as shown in fig. 2.

The heavy wire lead on pin 5 can be left attached to the crystal switch.

Now, looking down into the bottom of the overturned receiver, take a length of enamel-insulated copper wire, #24 is excellent, and wind seven turns around the vacant upper portion of the oscillator tank coil form. The turns starting at the middle of the form should go on clockwise, ending at the "top" of the form, that is, the end nearest you. Ground the bottom end of the tickler coil at the tube socket. Take the other end to the junction of the 22,000 ohm resistor and the 50 mmf capacitor mentioned above at the grid end, as shown in the schematic.

A 47,000 ohm 2 watt resistor should be inserted in the plate lead (blue wire) and a 100 mmf disc or tubular capacitor added from the hot side of the original tank coil to a ground on the tube socket to provide an r.f. ground.

The variable capacitor in the RCK is of course of the semi-butterfly type as shown in the diagram. It is slightly unusual in that this circuit is often found grounded at the mid-point of the capacitor whereas in the RCK it is floating above ground at that point.

The set should now tune all by itself. The crystal selector shaft may be replaced, and crystals used for spot frequencies. The receiver will operate at crystal frequency if a crystal is inserted, or will oscillate itself if no crystal is used. The v.f.o. may not oscillate at the same place with a crystal out as with one in, but this can be adjusted with the trimmer on the capacitor frame. It is a good idea, if possible, to set the tuning on a crystal frequency, with a signal source that you can count on such as a signal generator or frequency meter. Lock the dial, and do the conversion work. Then when you turn on the set you can bring the v.f.o. frequency to the proper point with the trimmer by comparing the v.f.o. and crystal modes.

I have found that in general the sets will need realignment after conversion. Mine have not tracked very well, i.e. tune less than the whole 50 megacycles on the dial. I do not claim the conversion is the ultimate—some changes in the plate dropping resistor or in the number of turns in the tickler coil might alter the frequency curve of the oscillator to improve the tracking. Certainly looser coupling here should be tried.

Do not wind the tickler directly on top of the existing coil. The great increase in capacitance to ground thus introduced makes it nearly impossible to trim the v.f.o. to the proper frequency within the trimmer range.

I started out by finding the crystal frequency on my h.f. receiver, by the way, and double-checked everything afterward by finding the v.f.o. signal at the same point on the h.f. receiver.

Interestingly enough, the receiver tuning is a great deal narrower with v.f.o. operation than with crystals. The crystal will oscillate even if you are tuned off-frequency several hundred kc, but the v.f.o. will be out of the audible range.

It is important to keep the oscillator injection voltage down as far as you can and still get re-

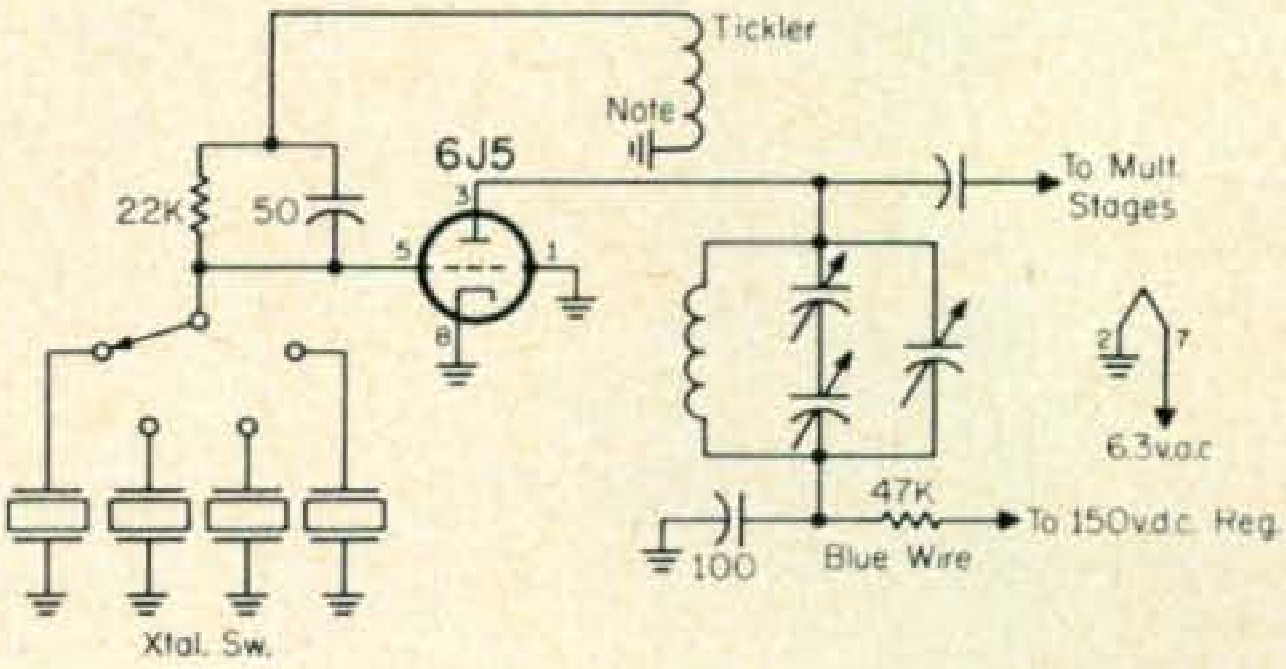


Fig. 2—A more detailed method of converting the RCK to a tunable receiver. Note: the tickler coil should be wound clockwise on the vacant top portion of the first multiplier stage tank coil. The coil should be wound starting near the chassis end and ending near the bottom plate (top). The end near the chassis is grounded at the 6J5 socket. It will not oscillate if the tickler is wound in the wrong "sense." Do NOT wind it over the existing winding.

liable operation with decent gain. Too much oscillator voltage can overload the automatic volume control circuit to the point that it cuts the r.f. gain back. This can be noted by trying the AVC-MVC switch in both positions. I found the 47 k dropping resistor was about right, but it might be useful in some cases to experiment with other values.

For those who want to try another approach, changing the grid circuit components to the recommended 22,000 ohms and 50 mmf, plus the lifting of the cathode off r.f. ground with the r.f. choke and the addition of the 10 mmf cathode-plate feedback capacitor will give a slightly different oscillator configuration that might track better.

Is it worth it? The RCK has two stages of r.f. amplification and even with the conversion is fairly stable. I am sure the noise figure is not up to the standard of the best converters now available, but I have gotten good use of it on local 2 meter work, and on the aircraft bands with a decent half-wave dipole on my front porch. No silk purse but a pretty good sow's ear. The Navships Book is 91642(A), 91497, or 900229.

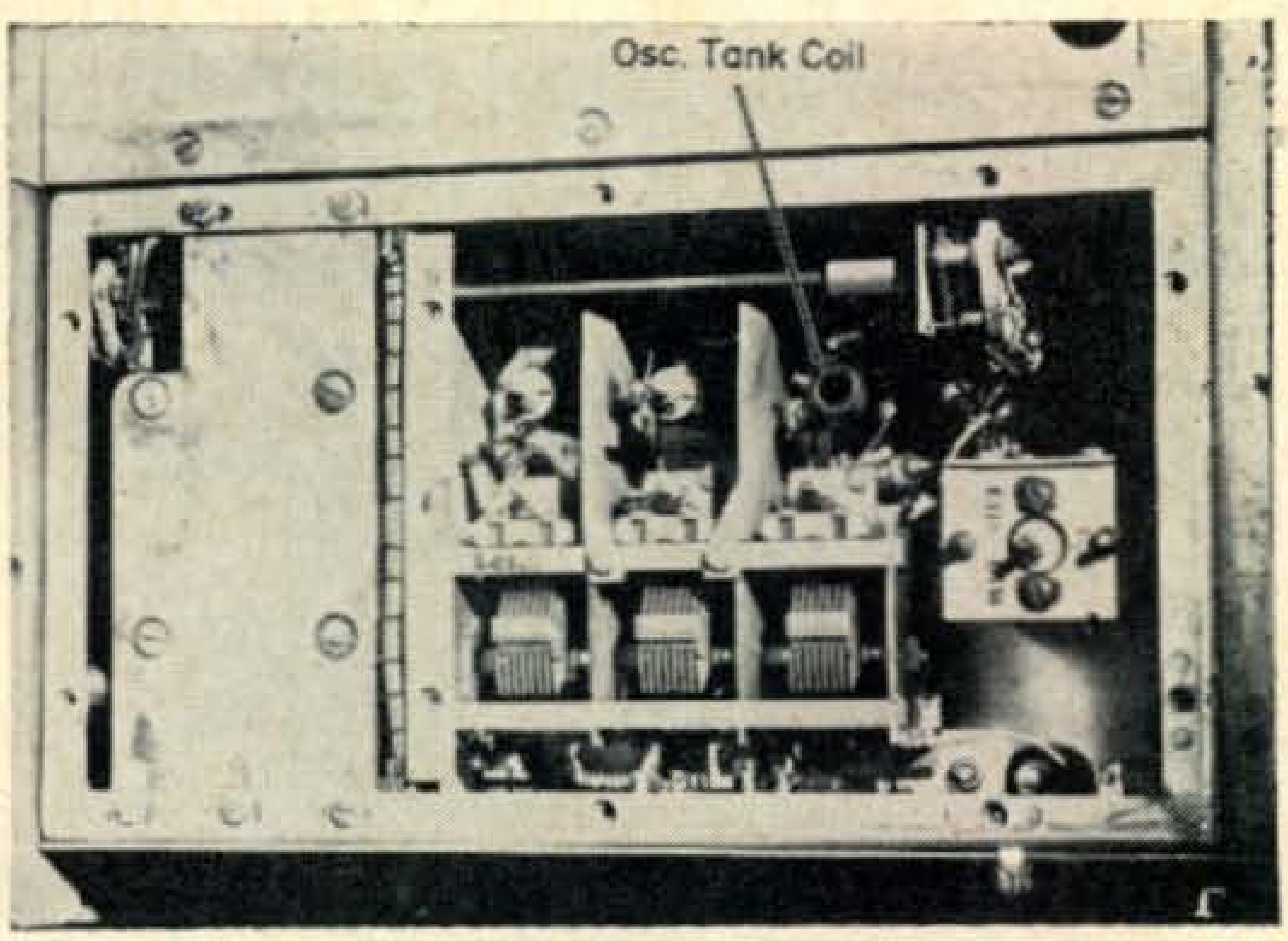
Manuals

I want to thank the people who wrote in answer to my recent requests for assistance on some surplus items. I still need the crystal frequencies and i.f. for the AN/TRC-7 if anyone knows them.

Dick Sanborn, A9FTE, wrote with some dope, reminding me that for those needing Army manuals, most of the equipment-to-manual cross-references are listed in Army Pamphlet 310-4. As was mentioned earlier, the thick MIL HDBKS such as -161, -162 and -172 have a lot of data on a wide range of sets. Some of these would be very useful to the Surplus Editor, who would pay a reasonable price for the test equipment HDBK (TM 11-487-H-1/1 the radar HDBK (TM 11-487-C); Radio Direction Finding (TM 11-487-4); Mscl Equipment (TM 11-487-I), and recent test equipment (TB 11-487-H-2).

Only a few companies will sell manuals for their equipment after it gets to the surplus market, and one of these is the Northern Radio Co., builder of RTTY terminal gear such as the type 107 FSK converter. In order to cover their office costs in selling such literature, Northern Radio has a $10 minimum order policy when paperwork is required. They will however sell manuals for much less—most of them are around $4 each—when you write them enclosing the proper amount plus 75¢ for postage, thus saving invoices and letters back and forth.

Northern Radio has been kind enough to give me a catalog of these manuals and their prices. I will furnish this information to anyone who sends me a stamped, self-addressed postcard bearing the type and model of Northern Radio gear for which the book is desired. For anyone needing the whole list, I will make copies for $1 plus SASE.



A bottom view of the RCK receiver, showing the oscillator compartment uncovered. The first oscillator tank coil is shown in the lower right center of the compartment between the crystal switch and the bottom section of the tuning capacitor. The tickler winding for the tuneable oscillator is wound on the near end of this form. The square can at the bottom of the compartment is the 12 mc i.f. output transformer from the mixer stage.

Since there are a lot of amateurs who are interested in antique radio equipment, even commercial designs such as McMurdo-Silver, Farnsworth, American Bosch, Atwater-Kent, Grunow, etc., I thought it might be worthwhile to mention that the Supreme Publications Co., 1760 Balsam Road, Highland Park, Illinois, still publishes a handbook of 240 schematic diagrams for commercial receivers made between 1926 and 1938. The book retails for $2.50. Supreme also has published annual books of about 200 diagrams of commercial equipment including TV, Radio receivers, stereo record players, etc., from 1939 to the present, also selling for $2.50 each.

I want to add a clarification of one reference in my RTTY surplus roundup in the August issue. The CV-31R/TRA-7 converter, part of the AN/GRC-26 set, and the CV-182/GRC-26A are very similar converters. It would be important to note that they both require associated power supply units which are often lost in surplus channels. The CV-182 power unit is PP-712/GRC-26. The CV-182 operates from a 440-510 kc i.f. input, and may be worked with two receivers for diversity operation.

Also along the lines of RTTY surplus, the AN/UXC-2 multiplex set is probably unsuitable for amateur purposes. It is a time *and* frequency division unit.

Finally, I want to note for many of those who have written to me for assistance, that there are more than a hundred schematics for surplus units in the *CQ Surplus Schematics Handbook*. Almost all of the older sets are covered there. Actual conversion data on many of the old standbys is found in *CQ's Surplus Conversion Handbook*, which has a particularly good section on the SCR-274-N and BC-603, 683 sets. These books are far better than any advice I can give in a brief letter.

I do not want to discourage anyone however, from writing about the less common, newer type of surplus, which I may not have seen before, and which may become tomorrow's standbys. ■

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FREQUENCY BANDS: 3.5-4.0; 7.0-7.5; 14.0-14.5; 21.0-21.5; 28.0-28.5; 28.5-29.0; 29.0-29.5; 29.5-30.0 mc (28.0 to 28.5, 29.0 to 30.0 requires extra crystals at users option).

SENSITIVITY: Better than 1 μv for 20 db S/N.

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Model HA-19 plug-in, 100-kc quartz calibrator available as accessory. **Amateur net, $19.95**

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FREQUENCY COVERAGE: 3.5-4.0, 7.0-7.5, 14.0-14.5, 21.0-21.5 mc and 28-30 mc in four 500-kc steps. Crystal supplied for 28.5-29.0 mc coverage. Other plug-in crystals at user's option.

PHYSICAL DATA: Size: 5⅞" x 13⅛" x 11". Shipping wt., 26½ lbs.

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Frequency Coverage: 50 to 52 Mc and 52 to 54 Mc (144 to 146 Mc and 146 to 148 Mc in the SR-42). **Power Input:** 10-12 watts. **Power Supply:** 115 VAC and 12 VDC (vibrator and line cord optional extra). **Transmitter Crystals:** high frequency type; provision for four (one furnished), plus external VFO, switch-selected from front panel. **Tubes:** 10, plus zener diode oscillator control and four diodes (11 tubes, 2 zeners and four diodes in the SR-42). **"S" Meter** automatically switches to RFO. **Cabinet:** "snap-off" type for easy access. **Size:** 5½" high, 12⅛" wide, 8¼" deep. **Shipping Weight:** 17 lbs. **Amateur Net Price: $199.95**

For further information, check number 43, on page 112

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SX28	79.95

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GR91	39.95
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R100A/S Meter, Speaker	99.95

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CN 220 7-11	34.95
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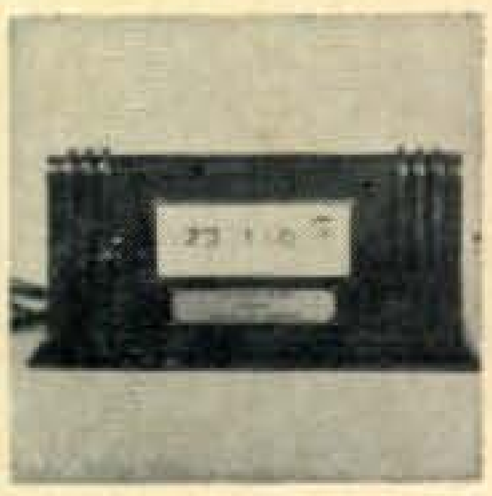

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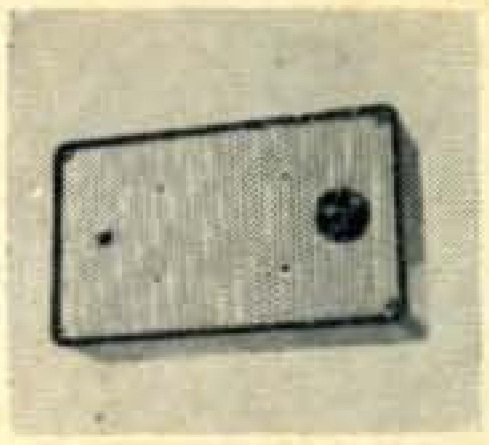

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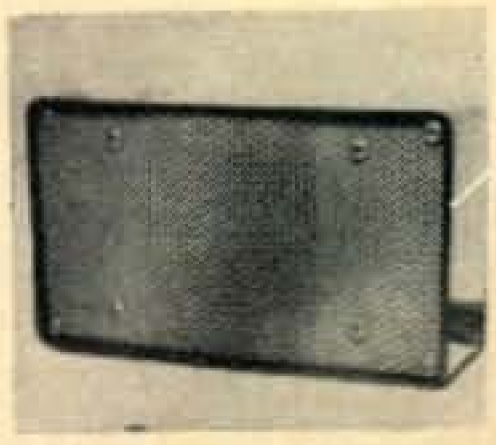


For further information, check number 44, on page 112

DX [*from page 84*]

QTHs and QSL Managers

K5AWR was reported as the QSL Manager for FG7XX in error. Dan is the manager for FG7XT. CW9AAK was erroneously reported as QTH POB 27. He is actually at POB *37*.

Northern California DX Club, Box 608, Menlo Park, Calif. 94025.

CT3AR	Between 12 July and 19 July 1966, via K6CYG.
EL2AT	via W4NJF.
F7CS	via VE4SK, 862 Minto St., Winnipeg, Manitoba.
FL8AC	G. Malosse, Box 121, Djibouti, French Somaliland.
HB0UP	via HB9UP.
HH9DL	Box 13, Dayton 59, Ohio.
KC6CK	Koror Palau W. Carolinas 96940.
KG6AAY/ Operators name	Box 110, U.S. NAVCOMMSTA, FPO San Francisco, Calif. 96630.
KJ6DB	via KH6EOQ, USATGH, Box 528, APO, San Francisco, Calif. 96438.
ON8XE/LX	via VE4SK.
PX1IE	via F9IE.
PX1JS	via F9JS.
PY7ACQ/P	CBDX, Box 842, Recife PE Brazil.
TF3EA	via VE4SK.
VP5RB	via W1EQ.
VP6WR	via WB2FSW.
3A0DX	via K6CYG.

Oscilloscopes [*from page 73*]

using some type of automatic key with which a steady train of pulses (or dots) may be obtained to key the transmitter. The horizontal sweep of the scope is then adjusted so one or two pulses of the r.f. envelope may be held steady for observation. Some typical patterns are shown in fig. 10.

Receiver Envelope Patterns

Envelope patterns also may be obtained on received signals. This requires coupling the vertical amplifier of the scope to an i.f. stage of the receiver through a 5-10 mmf capacitor. In a few newer receivers an i.f. output jack may be found at the rear of the set to do this. The scope amplifier must be capable of passing the particular i.f., which in some cases with modern receivers may necessitate the use of a wideband oscilloscope.

The receiver displays appear like those obtained at the transmitter, provided the i.f. bandpass is quite wide (10 kc or more); otherwise a true pattern will not be seen when distortion is present on the signal, particularly if you're restricted to the currently-used narrow i.f. bandwidths. The deterioration increases as the modulating frequency is raised, so the best results usually will be had with modulating frequencies below 300 c.p.s. or so. A.g.c. action also may confuse the picture, so it will be best to turn off the a.g.c. and crank down the r.f. gain below the overload point of the receiver.

R.T.T.Y.

R.T.T.Y. cross patterns are used to evaluate the performance and proper tuning of the R.T.T.Y. gear. To do this connect the horizontal and vertical amplifier inputs of the scope to the R.T.T.Y. terminal-unit *mark* and *space* outputs respectively. Turn the vertical and horizontal gain controls to minimum and adjust the centering controls of the scope so that the spot on the c.r.t. is located exactly at the center of the screen.

Next, with the receiver b.f.o. on, tune in a steady signal for a beat note at the *mark* frequency and adjust the horizontal gain of the scope for a horizontal trace of a given length across most of the screen. Then tune for a beat note at the *space* frequency and adjust the vertical gain for a vertical trace the same length as that set for *mark*. With the receiver correctly tuned the deflection of *both* the *mark* and *space* traces will be maximum and if the correct amount of shift is being transmitted, both traces will be of equal length. See fig. 10.

Conclusion

The primary concern in discussing the use of the oscilloscope for evaluating equipment performance has been to show how the different type displays are obtained and interpreted, in order that the reader may at least be able to recognize good or bad operation. ■

Contest Calendar [*from page 90*]

Scoring: Contacts with British Isles stations vary in point value according to the location of the entrant. If in Europe, 5 points. North America 15 points. Africa, Asia and South America 25 points. Oceania 50 points. In addition a bonus of 50 points may be claimed for the first contact with each British Isles country/numeral prefix. (i.e. G2, G3, GB2, GM6 and etc.) A possible 37.

Awards: Certificates to the leading station, both single and multi-operator, in each country and VE, VK, W/K, ZL and ZS call areas.

There is also a s.w.l. section with scoring similar to the transmitting section.

A summary sheet with all details and a signed declaration, and your name and address in BLOCK LETTERS is requested.

Logs go to: R.S.G.B. 7 mc Contest Committee, 28 Little Russell St., London WC1, England. Postmarked no later than November 28th.

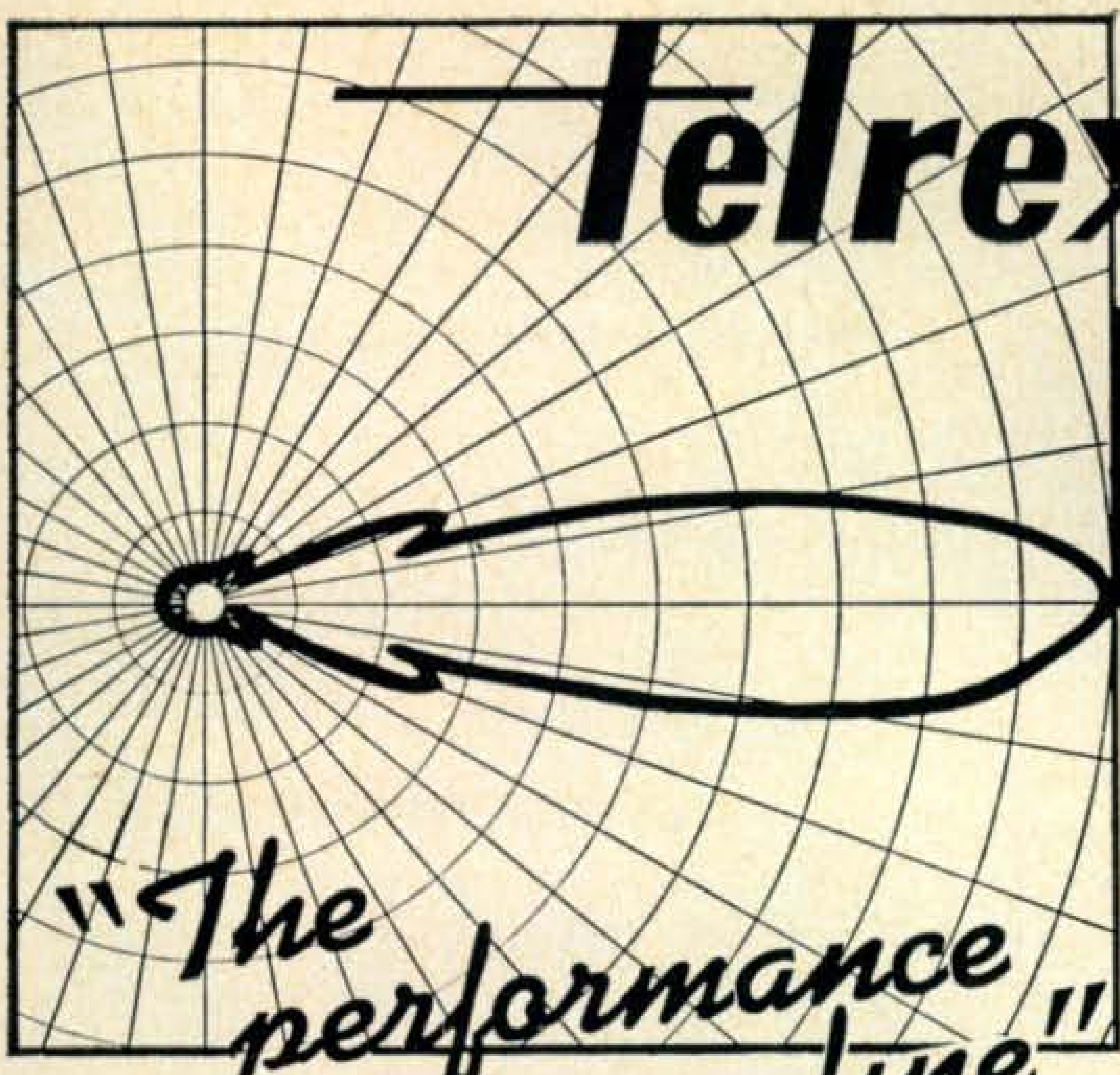
CQ WW DX

Complete rules in last month's CALENDAR if you want to review some of the finer points.

Following are a few reminders. The single band category is for single operators *only*. Multi-operator score is figured on all band operation, so there is no percentage in concentrating on only one band.

Single Transmitter stations are permitted only one signal on the air at the same time. Multi Transmitter operation permits all bands to be activated at the same time, but only one signal per band permitted.

Know your prefixes. EA6 (Baleric Is.) is not Spain, HC8 (Galapagoes) is not Ecuador, ZS3 (Southwest Africa) is not South Africa, just to mention a few. There are two countries under the GC prefix, Gurnsey and Jersey, and three for SV0 Greece, Crete and Rhodes. And remember, we use the WAE country list for Europe. Therefore IT1 (Sicily), UN1 (Karelia) and UA2 (Kaliningrad) count as additional countries.



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For further information, check number 25, on page 112

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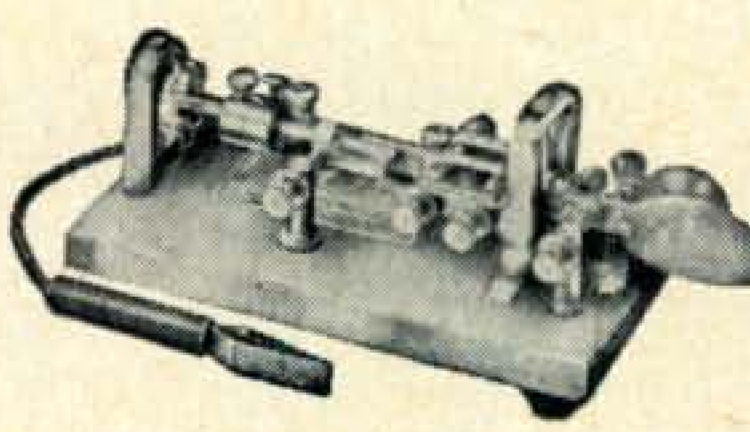

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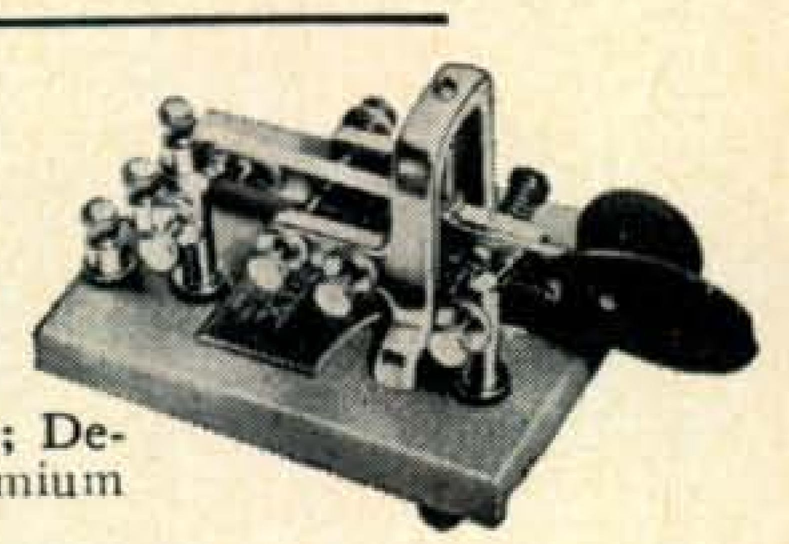

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FREE Folder

For further information, check number 26, on page 112

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Receiving Converter Model RTY-1

A new completely solid state RTTY receiving converter. Provides three common shift frequencies: 850, 425 and 175. Panel switch selects desired shift.

Audio filter type converter gives good discrimination between signals and noise or interference. Circuit is made up of limiter, amplifier/filter driver, detector, pulse shaper, and keyer. May be used for either FSK or AFSK.

Integral a.c. power supply uses zener diode regulation for dependable operation independent of line voltage variations.

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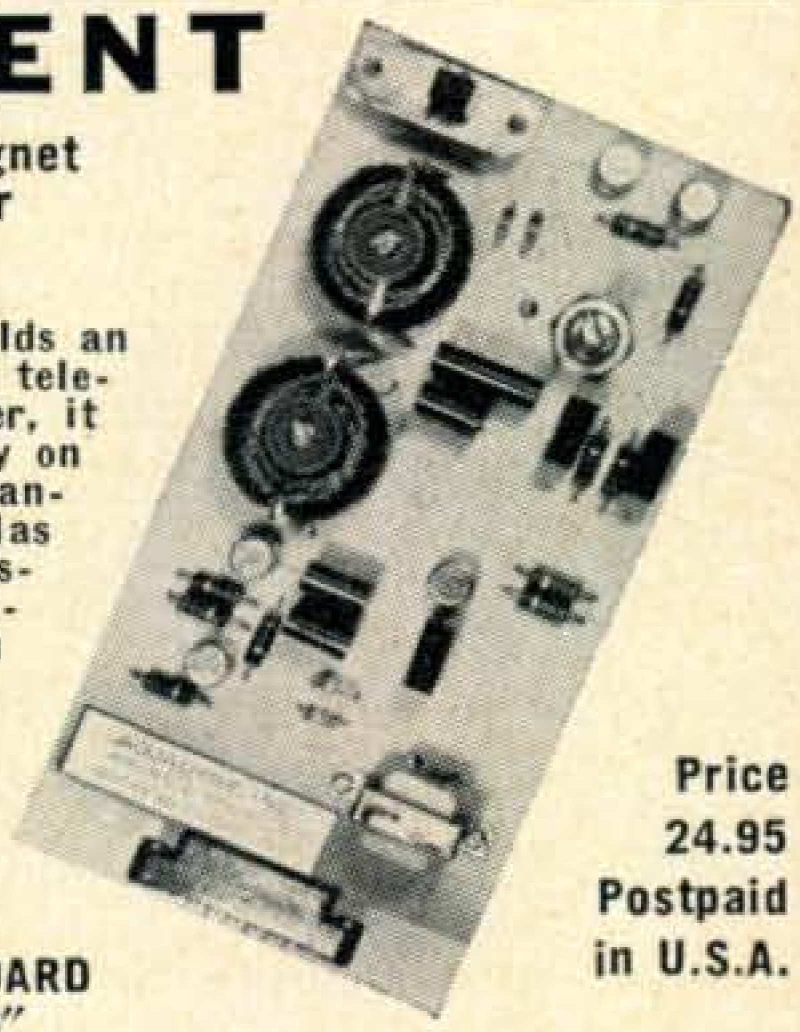
This is a kit that builds an elementary receiving teletype converter. However, it will produce good copy on better signals. All transistors are silicon. Has balance control, reversing switch, and operates from a 600 ohm source.

Power supply requirements are 12 v D.C. 70 ma. Drives the selector magnet directly.



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Don't expect us to dig them out for you, although we will give you credit for any omissions that we might catch during our checking.

If you work a station giving out a wrong zone number, correct him. Some of the DX stations are good enough to take time out and correct some of our uninformed W/Ks. Yes, there still are some.

Check W3ASK's PROPAGATION Column. George's annual contest forecasts are usually quite accurate.

Official log and summary sheets are not really required. However its very helpful to us if you keep your station entries at 40 to the page, and indicate the Zones and Countries only the first time they are worked. Of course the official forms make it easier.

And last but not least, don't forget to send us your log, regardless of the number of contacts.

Good luck, see you in the pile-ups.

73 for now, Frank, W1WY

Radiation [*from page 62*]

used in medicine is generated at about 25 kv, and most are from 50 to 100 kv in diagnostic x-ray work, and above this in therapy. X-ray tubes, even with tungsten or platinum targets, are only about 2% efficient in producing x-rays, so the materials in ordinary radio tubes can't do a very good job of producing x-rays. If you are worried, take a piece of un-exposed film, cover it to keep out the light, and cover part of it with lead, or lead foil. Leave it close to the suspected source for an hour or so, then develop it; if you can tell where the edge of the lead was on the film, you are producing x-rays.

Infrared

Infrared is produced at lower voltages, but it is effective only as heat, and would be recognized at once.

Ultraviolet might be present, in fact, is present within the tubes if the filament is on, along with visible light and infrared, but the glass envelope filters it out, just as ordinary window glass filters the ultraviolet from sunlight. If present, it would have exactly the same effect as the ultraviolet of sunshine, produce a burn, cause early aging of the skin, just as occurs when you get too much of a tan, and predisposes to the development of skin cancer, just as does too much sunshine.

So, unless you are working with voltages above 15 kv, you need not fear ionizing radiation or x-rays. Below that you can get a burn from high frequency or infrared, or a fever from the diathermy effect, and that's about all. ■

2000 Watts P.E.P. [*from page 55*]

noise out in DX land with the two gallon peak rig. But first there must be the usual "smoke test" and a tune up to full power with an antenna or kw dummy load. Tune the exciter (with both amplifiers off) for enough c.w. output to give a full scale reading on the forward power meter of one of the amplifiers. The meter sensitivity control can assist in this adjustment. Then alternately adjust the two capacitors and the coil in the pi network for minimum s.w.r. on the meter (switched to read s.w.r.). Continue alternating until the s.w.r. is 1:1 and the meter reads zero. If desired one capacitor may be left at 100 mmf or so and the coil and one capacitor alternately tuned. Or, the coil may be fixed near the proper value and the two capacitors alternately adjusted for 1:1 s.w.r. With the amplifiers off, the exciter is fed straight through the amplifiers to antenna or dummy load. Relative Power and s.w.r. can be read from either HA-14 meter. Reduce the r.f. output from the exciter to a minimum. Turn on one HA-14, insert a bit of r.f. at the exciter to get a forward power indication on the meter and peak the amplifier tune control.

Turn off the first linear and turn the second one on, peaking it in the same manner. Now turn on both amplifiers. If a high wattage light bulb is connected as a dummy load a distinct change in brilliance will be noted as one and then the second amplifier is added to the exciter, giving a visual display of increasing power.

With everything functioning properly it was time to try it out on the air. Our antenna (a vertical ground plane) was connected and the pi-network readjusted for 1:1 s.w.r. as seen by the amplifiers. A CQ brought a response from WA4LWM in Florida. We wanted a local station as well, for good consistent, no-fade, comparisons. A landline call brought W4MTH/8 in Dayton on frequency. Both Jerry (WA4LWM) and Lew (W4MTH/8) were very tolerant and helpful in checking power reductions as linear amplifiers were cut in and out, in evaluating audio quality and in tuning for spread above and below center frequency. The process was done with two different exciters, a Heathkit HW-32 and a Viking Invader. Reports were exceedingly gratifying and the system met all test objectives. Audio remained high in quality and there was no distortion with any combination on the air. The spread was pleasingly narrow.

To check diplexer balance the power dissipated in the output diplexer terminating resistor was measured. When both amplifiers were functioning normally it was less than one watt, showing excellent balance.

It is important to note that neither exciter tried would drive the diplexed amplifiers to their full power capability. To get maximum advantage out of the combination of linear amplifiers a full 200 watts p.e.p. of r.f. drive is needed. This of course can not be obtained from an exciter running 200 watts p.e.p. *input*. A number of exciters are available which could easily drive the diplexed amplifiers to their full capability. Or a pair of amplifiers connected in a grounded cathode configuration would also work with the diplexers and would require considerably less drive.

Even with moderate drive it is advisable to add a fan of some type to keep air moving over the

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Squires Sanders

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amplifier tubes, particularly if the rig is stacked up as in the photos. In our test set-up an ordinary small house fan was lashed to the side of the amplifier "sandwich" and kept the equipment comfortably cool.

Conclusion

Construction of the 2 kw p.e.p. diplexed Linear Amplifier System is quite simple and considerably less expensive than commercially available single amplifiers of equal output. The diplexers need not be an offensive sight and can be stowed in a small space out of sight. One of ours was done in display board fashion only to give a better pictorial presentation of its construction and operation. The system provides the operator with maximum legal power and the ability to selectively reduce power in keeping with the FCC's rule to use only the power necessary for the contact.

Our sincere appreciation is expressed for the excellent cooperation and critical reporting of WA4LWM and W4MTH/8 during on-the-air testing, and to George Hunter of Dayton for his cheerful photographic assistance. ■

Satellite Antennas [*from page 42*]

A small spring must be installed which will press against the end of the motor shaft and hold the brake clutch engaged. When the motor is energized, the magnetic forces pull the armature against the spring, center the armature in the

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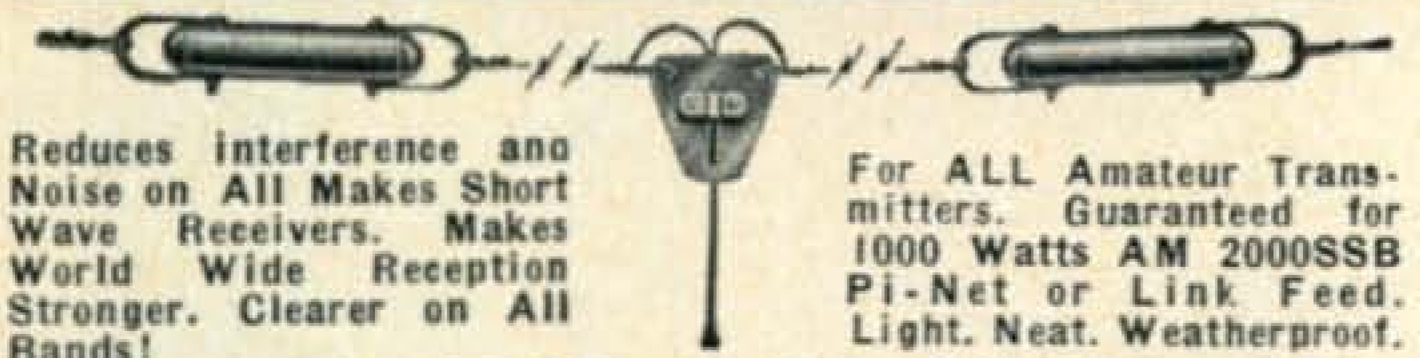

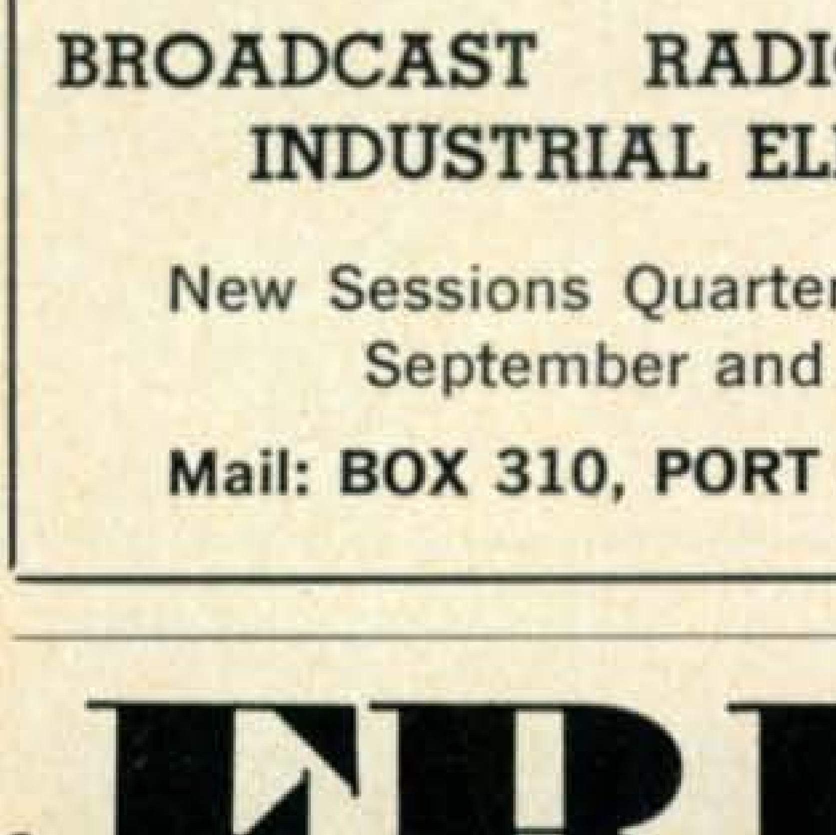

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field, and release the brake clutch.

The spring is fashioned from flat spring copper about ¼ × 1 inches and can be held in place under an existing screw that holds the indicator pot to the end of the motor. Spring tension should be adjusted for best clutch pressure consistent with good motor starting and armature pull-in.

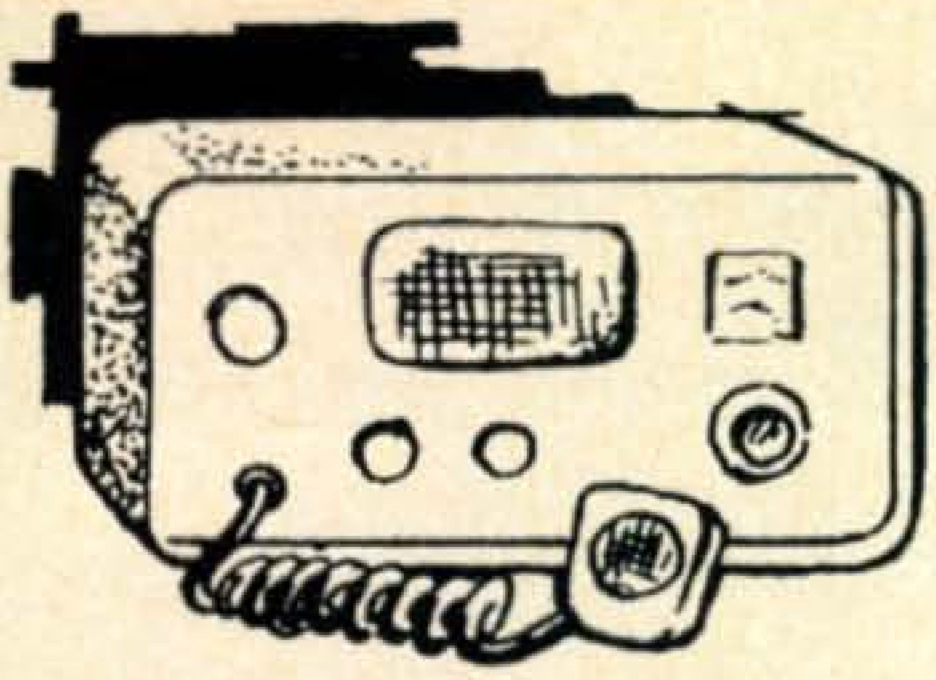
Notes on the Mechanics

The mast is approximately 2″ diameter and 10′ high. It turns freely in a slightly larger piece of pipe that is imbedded in concrete. Guy wires attach via a slip ring at a point just below the rotor box.

The rotor box is fabricated from ⅛″ aluminum (old rack panels) using ¼″ diameter bolts. Its bottom is approximately 12 × 24. The end plates are approximately 12 × 12. A four inch skirt extends below the bottom for torsional strength. All corners are held firm with angle brackets. The rotor box mounts to the mast with the rotor to mast adapter plate that is supplied as part of the TR44 rotors. ■

Propagation [*from page 88*]

South-east Asia	15-18 (1)* 08-10 (1) 13-14 (1) 14-15 (2) 15-17 (3) 17-19 (2) 19-20 (1)	06-08 (1) 08-10 (2) 10-11 (1) 18-19 (1) 19-20 (2) 20-22 (1)	01-02 (1) 02-04 (2) 04-08 (1)	02-04 (1)
Far East	14-18 (1)* 12-14 (1) 14-16 (3) 16-18 (2) 18-20 (1)	06-07 (1) 07-10 (3) 10-12 (2) 12-19 (1) 19-21 (3) 21-02 (2) 02-04 (1)	23-01 (1) 01-03 (2) 03-08 (1)	01-03 (1)
Pacific Islands & New Zealand	13-16 (1)* 16-18 (2)* 18-19 (1)* 09-13 (1) 13-16 (2) 16-18 (4) 18-19 (2) 19-21 (1)	06-07 (1) 07-09 (3) 09-12 (2) 12-16 (1) 16-18 (2) 18-20 (4) 20-23 (3) 23-01 (2) 01-02 (1)	21-22 (1) 22-05 (3) 05-07 (2) 07-09 (1)	22-00 (1) 00-05 (2) 05-07 (1) 02-06 (1)†
Austral-asia	14-16 (1)* 16-18 (2)* 18-19 (1)* 11-13 (1) 13-15 (2) 15-16 (3) 16-18 (4) 18-19 (2) 19-20 (1)	06-08 (1) 08-10 (3) 10-12 (2) 12-16 (1) 16-18 (2) 18-20 (4) 20-00 (3) 00-01 (2) 01-04 (1)	01-03 (1) 03-06 (3) 06-09 (1)	00-04 (1) 04-06 (2) 06-08 (1) 04-07 (1)†
Northern & Central South America	08-12 (1)* 12-15 (2)* 15-16 (1)* 05-07 (1) 07-11 (2) 11-14 (3) 14-16 (4) 16-18 (3) 18-19 (1)	05-06 (1) 06-09 (2) 09-12 (1) 12-14 (2) 14-15 (3) 15-17 (4) 17-19 (3) 19-20 (2) 20-00 (1)	18-19 (1) 19-01 (3) 01-03 (1) 03-05 (2) 05-06 (1)	19-22 (1) 22-01 (2) 01-04 (1) 23-02 (1)†
Southern Brazil, Argentina, Chile & Uruguay	09-12 (1)* 12-15 (2)* 15-16 (1)* 06-13 (1) 13-14 (2) 14-15 (3) 15-16 (4) 16-17 (2) 17-18 (1)	06-15 (1) 15-16 (2) 16-18 (4) 18-20 (2) 20-00 (1) 00-02 (2) 02-03 (1)	22-00 (1) 00-02 (2) 02-04 (1)	00-02 (1)
Mc-Murdo Sound, Antarctica	09-14 (1)* 07-14 (1) 14-17 (2) 17-19 (1)	15-17 (1) 17-19 (2) 19-21 (3) 21-23 (2) 23-01 (1) 06-11 (1)	23-05 (1)	*Nil*



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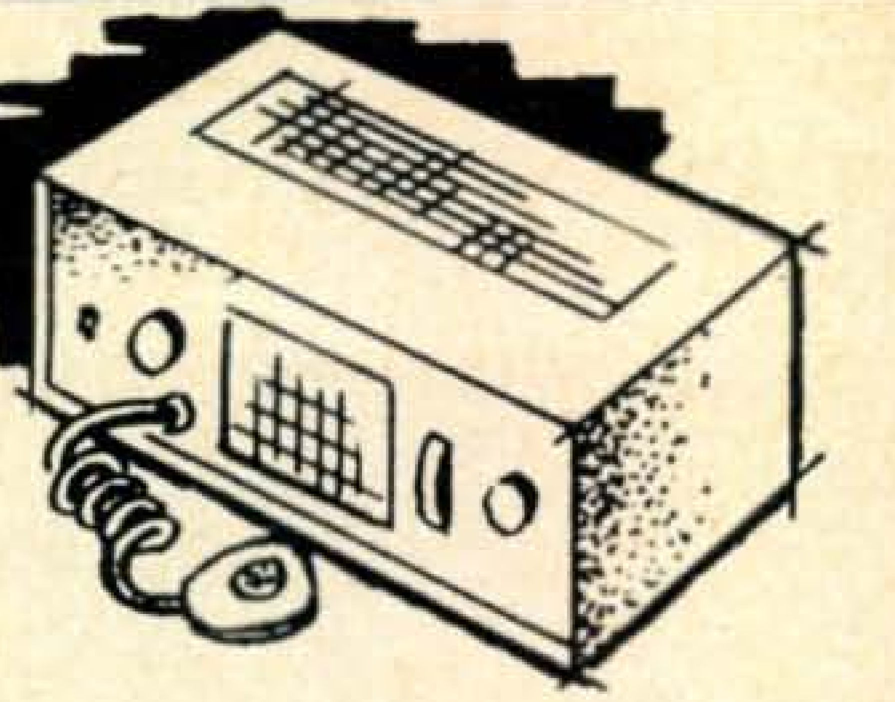

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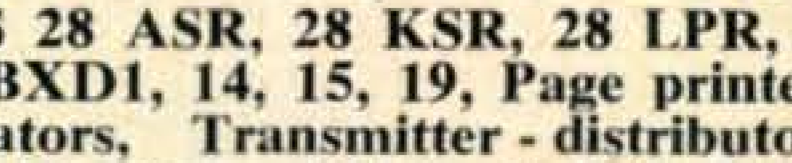

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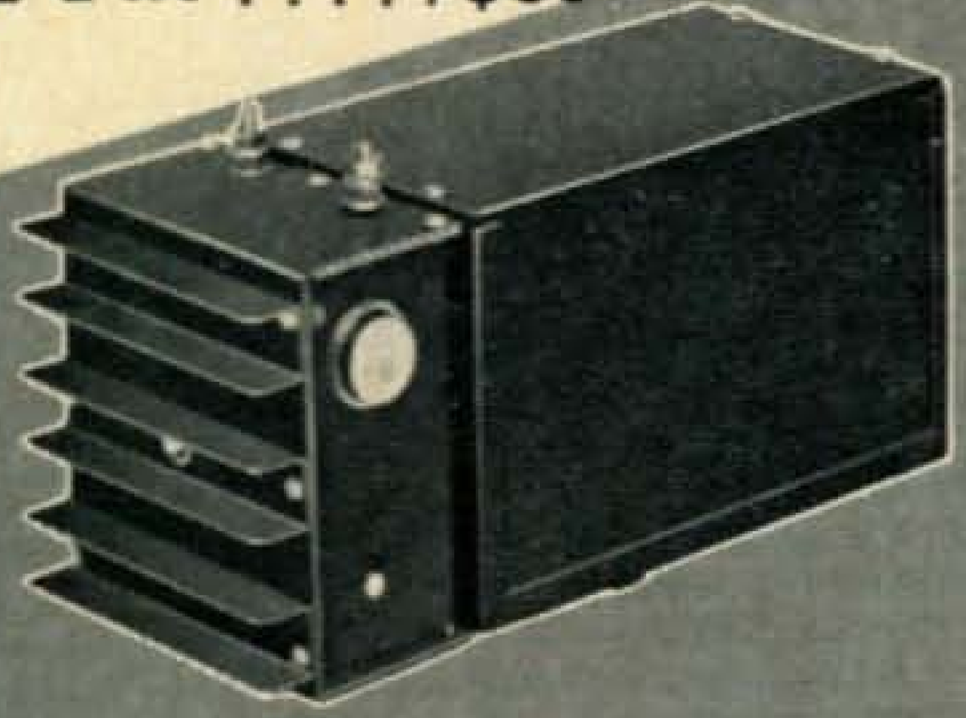

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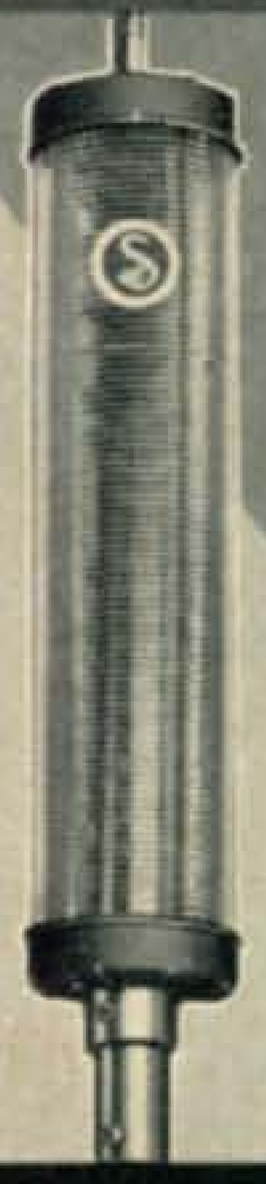

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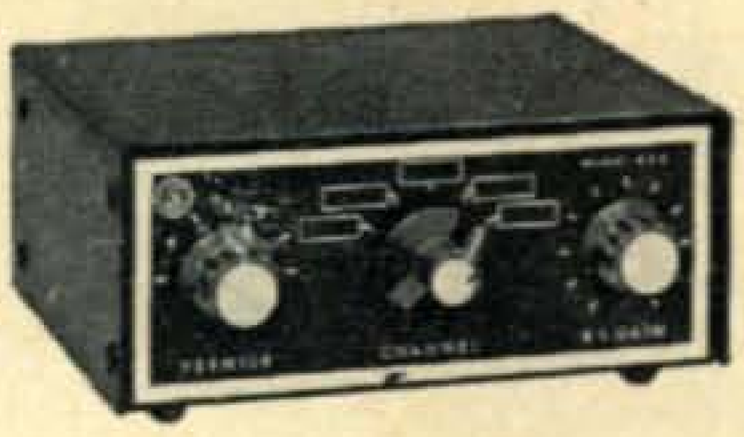

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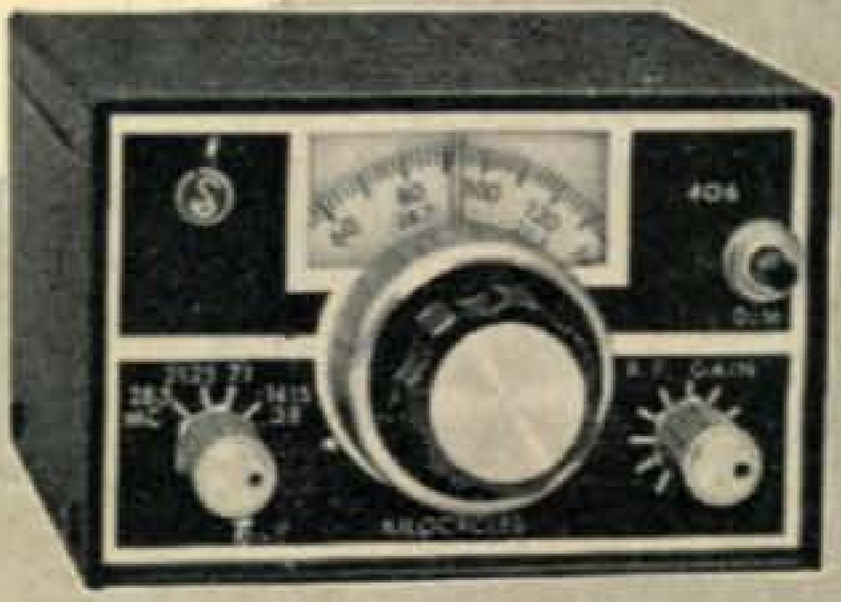

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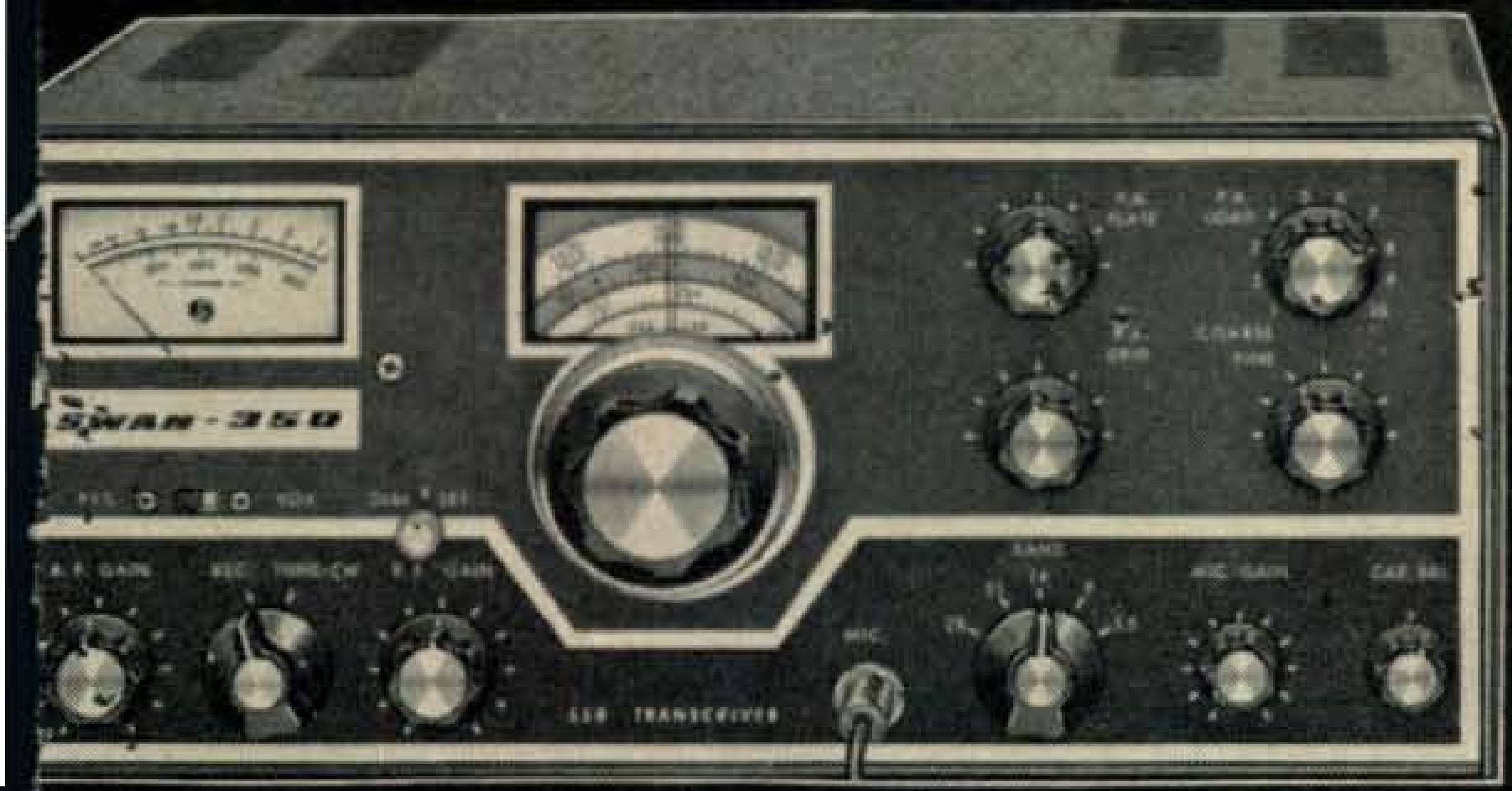

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WRL's Bluebook saves you money! These prices without trades: Thor & AC—$323.10; KWM1—$224.10; III/6m—$125.95; HT40—$49.50; SX99—$85.05; Apache—$116.10; HX10—$260.10; SR46—$134.10; HQ170C—$188.10; King 500C—$233.10; 2A—$161.10; Ranger I—$89.95; Hundreds more, free list. WRL, Box 919, Council Bluffs, Iowa 51501.

SURPLUS electronics manuals. List 10¢. W3IHD, 4905 Roanne Drive, Washington, D.C. 20021.

.01% Accurate audio fork oscillators for RTTY, Etc. Box 65, Geneva, Illinois 60134.

SAVE ON ALL new or used ham gear. Call or write Bob Grimes, 89 Aspen Road. Swampscott, Mass. 617-598-9700.

WANTED: Laboratory Test Equipment. Electronicraft, Box 13, Binghamton, New York 13902.

FREE COPY of totally new HAM PUBLICATION. Send QSL or postcard today. Nothing like it before! HAM'S MARKET NEWSPAPER, Box 13934, Atlanta, Georgia 30324.

WANTED: Military, Commercial, SURPLUS . . . Airborne, Ground. Transmitters, Receivers, Testsets, Accessories . . . Especially Collins . . . We Pay Cash and Freight . . . RITCO, Box 156, Annandale, Virginia (703)-560-5480 Coect.

RESEARCH SERVICE—Research bulletins on detailed studies of QRM, Frequency Usage. Incentive Licensing and other subjects. Engineering reports on new ham equipment detailing unbiased best buys. No advertising accepted. Annual subscription $3.00. Amateur Radio Research Service, Box 879, Mesilla Park, New Mexico, 88047.

BUILD A CODETYPER. Transistorized electronic computer-typewriter for Morse teaching or keying your rig with fb fist. For schematic, parts list and technical dope send $2 to Computronics Engineering, Box 6606 Metropolitan Station, Los Angeles 90057.

BARGAINS! Transmitters, receivers offered, wanted in "The Ham Trader." Next 12 interesting issues $1. Sample free. Brand, WA9MBJ, Sycamore, Illinois.

NOVICE CRYSTALS 80-40M $1.05 each. Also other freqs. Free list. Nat Stinnette W4AYV, Umatilla, Florida 32784.

RTTY GEAR for sale. Write for list-issued monthly. 88 or 44 Mhy toroids. Five for $1.75, postpaid. Elliott Buchanan W-6-VPC-1067 Mandana Blvd., Oakland, California 94610.

"HOSS-TRADER" "Ed Moory, Say's if "You can pay CASH and NO trade involved you can purchase the following DEMONSTRATOR Equipment with factory warranty: NCX-5, $479.00; TR-4, $489.00; Swan 350, $349.00; Galaxie 5, $339.00; R4-A, $329.95; NCL-2000, $529.00; KWM-2, $895.00; 75S-3B, $499.00; 30L-1, $429.00; SB-34, $329.00; New Ham-M Rotor & Demo Mosley TA-33 Beam $179.00; Demo Ham-M Rotor, $89.95; T4-X, $329.95: Package Deal, New NCX-5 & Demo NCL-2000, Reg. Price $1,370.00, Cash Price, $995.00; Package Deal, New Swan 350 & Demo Swan Mark I 2000 Watt Linear, Reg. Price, $963.00, Cash Price, $775.00: Reconditioned Gear: HT-37, $219.00; 2-B, $189.00; SX-111, $129.00; SB-33, $189.00; "Ed Moory Wholesale Radio, Box 506, DeWitt, Arkansas. Phone 946-2820.

HEATHKIT TECHNICIAN will build your Heathkit, Write: W8TXX, Route 1, Box 173, St. Joseph, Michigan 49085.

HRO-60 National Receiver, coils A, B, C, and D in good condition. B. J. Williams, 2935 Marne Avenue, Norfolk, Virginia 23509.

ASSORTED HARDWARE (nuts, bolts, screws, etc.) 2 lbs for one dollar, plus postage. B. J. Williams, 2935 Marne Avenue, Norfolk, Virginia 23509.

CORNELL AMATEUR RADIO CLUB auction, November 5th at Barton Hall. Bring equipment to sell.

HAVE: 4X500's, 4CX250's, 4X150's. Swap for old toy trains. W3SYT, Rockwell, 8672 Lincoln Blvd., Pittsburgh 15237.

FOR SALE . . . Heath HW-32 with HP-20 AC P/S; two 4-1000A's like new, ABT 30 hrs. use. Best offer. WANTED . . . Vocaline 465 MC Equipment: JRC-400, JRC-425, AT-30 remote type. Also 144, 220, 420 MC gear. What have you? Grant C. Armstrong WA1EEW, 49 Colonial Lane, West Dennis, Mass. 02670—phone: 617-398-9103.

VHF ROUNDUP Oct 8, Dellemortes Country Manor Rte 49, Cleveland N.Y. Speakers W3SDZ, W2IXU, W1HDQ. For information write W2RHQ, 420 Beattie Street, Syracuse, New York. Tickets $6.00. $7.00 at door.

HERE'S THE CHEAPEST way to DXCC, WAZ, WTW. Telrex TM30D wide spaced Triband Beam new March 1966 Serial 35012; yours for $225.00. Bandit 2000A converted to 2000B, Serial 439 has four new 572B's—$215.00. Heath SB-300 receiver with CW filter mint condition $175.00. K4ZJF, Milt de Reyna, 4030 Hallmark Drive, Pensacola, Fla. Phone Area 904 433-6552.

WANTED: Printing press and supplies for 2 walkie-talkies BC-611-F Frequency 3885. Mint Condition. K3IGO, 1917 Haywood Street, Farrell, Pennsylvania 16121.

FOR SALE: Lettine Model 240 Xmtr with coils for 80, 40, 20, and 10 $40. Heath VF1 VFO with power supply $20. Heath AC1 Coupler $10. W3ZWG, 12 Madison Road, Herminie, Penna. 15637.

APACHE—SB-10 in good condx. Solid State Rectifiers. 6146-B *tubes*. For sale or swap for SB-200. Make offer. Leiper Read, W2IUY, 12 Hyde Street, Whitney Point, N.Y.

SELLING OUT—SX101 MKIII excellent condition, Reconditioned $100.00, also new and unused equipment as follows; Matching Hallicrafter R48A speaker $10. Hallicrafter T.O. Keyer HA1 $50. Vibroplex Key $10., Knight P2/SWR Bridge $10., Knight VTVM KG-620 (factory checked) $15., Dow Key DK60G2C Relay $8., Hygain Lightning Arrestor $10. Turner SSB mike $8. Cash. f.o.b. Neenah, Wis. K9LWG Dr. O. E. Larson, 449 Edgewood Court, Neenah, Wisconsin. Phone 1-414-725-5227.

FOR SALE: RME 6900 Ham Band Receiver, Mint condition, will ship, $150.00, L. E. Ingram, 45 Larry Drive, Decatur, Illinois.

SUBMINIATURE: A complete line of tiny radio transmitting devices, including cordless microphones, telephone transmitters, etc. Applications: surveillance, business, industrial, monitoring. Price range: $150.00 up. Literature available. L. N. Schneider, 958 Alan Drive, Wantagh, N.Y.

FOR SALE: Like new, Johnson Viking 6N2 and 6N2 VFO both for $115.00. SX 99 receiver with matching speaker R46B fine condition $75.00. Ship above by express. Frank Susnik, W0ARZ, RR4, Pittsburg, Kansas 66762.

SELL OR SWAP for guns; HQ110 receiver $49. B&W 5100 transmitter $38. Eico grid dipper $7. Knight SWR meter $7. DB23A Preselector $11. Knight signal generator $9. All for $100, Express collect. Lueck, 133 California, Dyess AFB, Texas.

The MANCHESTER RADIO CLUB announces Oct. 22nd as the date of their annual banquet. All amateurs are welcome. For further information write to P.O. Box 661, Manchester, N.H. 03105.

HA-350 receiver; Utica 650A 6m transceiver; "Squalo." Excellent. Thurber, 103 Fortuna, Atwater, Calif.

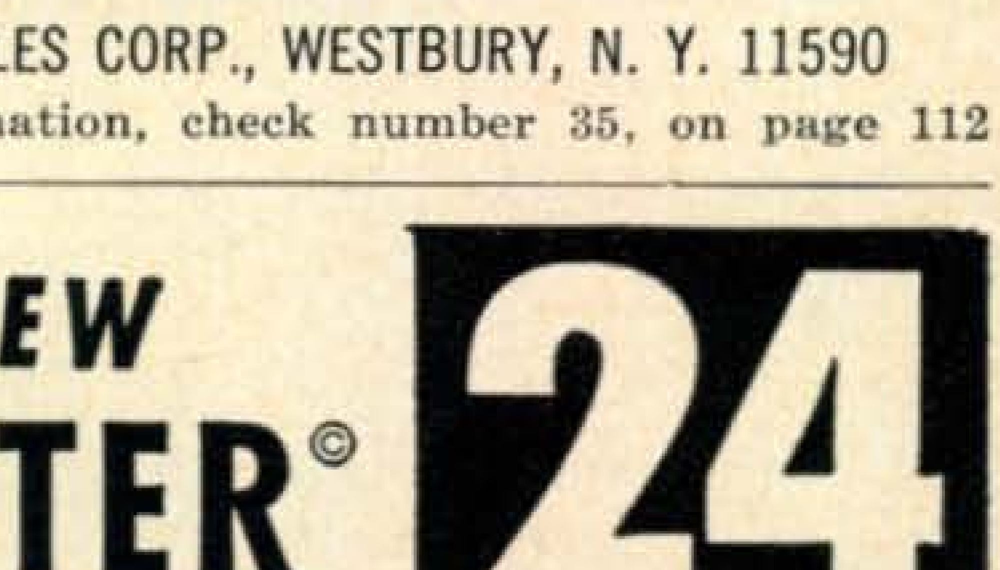
FOR SALE: GOLDKIT THRILLER transceiver write A. T. Cline Jr. 240 Peachtree Street NE, Atlanta, Georgia 30303.

WANTED: GOLDKIT THRILLER or E137 DX unit box 1220 Jacksonville, Florida.

WANTED—QST's—Last four issues needed to complete private collection. 1916—FEB., MAY, JUNE, JULY. Any reasonable price paid. K2EEK, CQ Magazine, 14 Vanderventer Ave., Port Washington, L.I., New York 11050.

WANTED . . . Silver dollars. Any condition, will buy or trade. Drop a line if you have any other coins for sale or trade. Scott Cowan, Dept. J5, 73-62 Bell Blvd., Bayside 64, N.Y.

VIKING VALIANT II 250 Watt Phone transmitter, never used—Cash & Carry $150. Jr. H.S. 74 Queens, 61-15 Oceania Street, Bayside, N.Y. BA 4-8423.



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NEW from **International**

SINGLE SIDEBAND
9mc EXCITER-DRIVER
50-54mc MIXER-AMPLIFIER

The SBX-9 Exciter-Driver and the SBA-50 Mixer-Amplifier provide the perfect combination for 50-54mc SSB operation. Performance, versatility and reliability are incorporated into this new SSB pair. A tremendous value at a low price!

Model SBX-9

SPECIFICATIONS:
Exciter-Driver 9mc

Tubes:	6BH6 Oscillator 12AX7 Audio 7360 Bal Modulator 6BA6 RF Amplifier
Filter:	Four crystal half lattice Carrier Suppression 45db min. Unwanted SB Atten. 40db min.
Output:	Provides voltage drive for mixer such as SBA-50
Controls:	Carrier Balance Microphone Gain Test Switch USB-LSB Switch
Metering:	RF output for balance adjust. Two sensitivity ranges available with front panel switch.
Misc:	Relay included for push-to-talk operation. Crystals for upper and lower sideband included. Requires high impedance microphone. For operation on 117 vac 60 cycle power.

$125.00

Order direct from
International Crystal Mfg. Co.

Model SBA-50

SPECIFICATIONS:
Mixer-Amplifier 50-54mc

Tubes:	6U8A Oscillator-Mixer 12BY7A Amplifier 6360 Linear power amplifier
Drive:	Requires 9mc sideband signal from SBX-9
Output:	SSB single tone 10 watts
Controls:	On-Off Power PA Grid Tune PA Plate Tune PA Load Tune Metering Switch
Metering:	Oscillator 9mc Drive Buffer Grid PA Grid RF Out
Crystals:	Three positions, uses 3rd overtone 41-45mc range. Crystal frequency = final frequency —9mc
Misc:	Accessory socket provided for connecting keying circuit to SBX-9. Comes with three crystals. Specify frequency when ordering. For operation on 117 vac 60 cycle power.

$145.00

INTERNATIONAL

CRYSTAL MFG. CO., INC.
18 NO. LEE · OKLA. CITY, OKLA. 73102

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One for the road,

or. . . do you need a new rig for fixed-station use? Or a second or even third rig for acation or even portable operation? Or a replacement for a single or tri-band transceiver? or that matter, the brand-new National 200 five-band transceiver, at only $359, is a natural or *anything* that demands top-notch SSB, CW, and AM performance on the 80 through 10 eter bands with minimal investment. Traditional National Workmanship and our one-year uarantee are yours, in a five-bander priced even lower than a kit rig!

▪ Complete coverage of the 80 through 10 meter bands. ▪ 200 Watt PEP input on SSB, plus rid-block CW and AM. ▪ Separate product and AM detection plus fast-attack slow-release GC in all modes. ▪ Crystal-controlled front end and single VFO gives high stability, plus dentical calibration and tuning rate on all bands. ▪ Crystal lattice filter for high sideband uppression on transmit, and rejection of adjacent channel QRM on receive . . . plus solid-state alanced modulator for "set-and-forget" carrier suppression. ▪ Operates from new low-cost C-200 supply ($75.00) or from NCX-A or mobile power supplies. ▪ Extra features like: ALC; 5:1 planetary/split gear tuning drive; automatic carrier insertion in AM and CW modes; niversal mobile mount included.

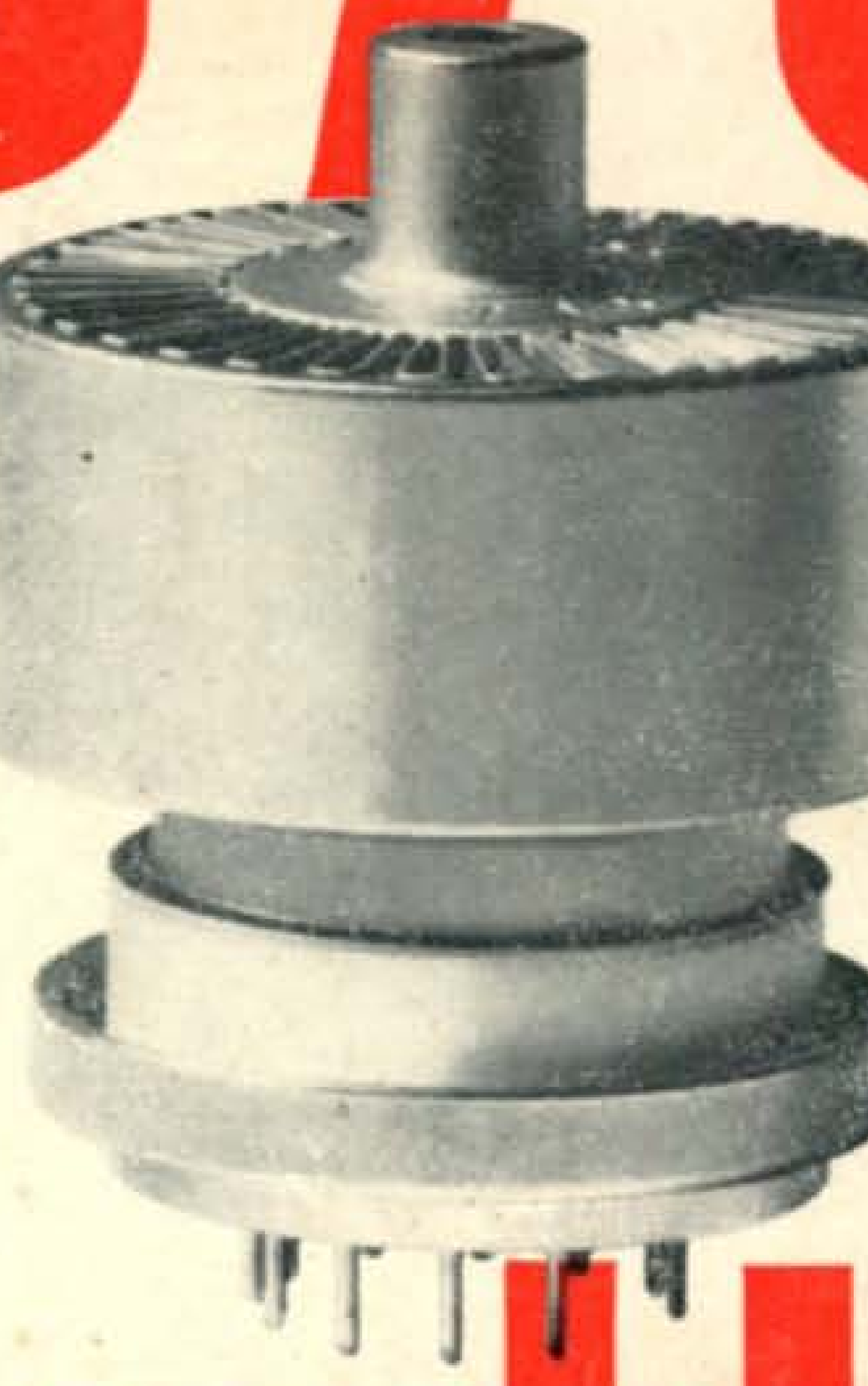
Your dealer has the National 200 in stock right now. See him today for a demonstration.

New National 200, of course.

NATIONAL RADIO COMPANY, INC., *37 Washington St., Melrose, Mass. 02176*

For further information, check number 50, on page 112

570 watts output in Class AB_2



RCA-8122 beam power tetrode shown actual size.

The RCA-8122 has power and reliability that's *hard to beat*—more than 50% greater dissipation capability than older tubes of comparable size. Used in the latest commercial equipment, or in your own project, the RCA-8122 can deliver power and efficiency with as little as 5 watts drive.

This low-cost forced-air-cooled beam power tube is designed with the builder in mind. . . . Use it with coaxial, strip-line, or conventional lumped tank circuit construction. Get broad-band neutralization on upper frequencies with only a series-tuned capacitor in one cathode lead. Ceramic-and-metal construction and special electrode configuration eliminate mechanically-caused noise and provide extreme sturdiness even at high operating temperatures.

Whether you're planning to buy or build, make sure you take advantage of the latest advances in tube technology with the RCA-8122—made by the people who gave you the 6146. On the amateur bands, it's years ahead!

Full CCS ratings up to 500 MHz. For use as rf pow amplifiers; oscillator; regulator; distributed amplifier or linear rf power amplifier in fixed or mobile equipment . . .

- 380 Watts PEP Output at 30 MHz Class AB_1
- 570 Watts PEP Output at 30 MHz Class AB_2
- 300 Watts CW Output at 470 MHz Class C

For complete technical information, write to RCA Commercial Engineering, Harrison, N. J. for a copy of RCA-8122 Data Bulletin (Revised 6-66), and Application Guide ICE-300.

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